CALFED Water Quality Program

COMPONENT REPORT
Draft
August 1997

GOOD WATER QUALITY FOR
ALL BENEFICIAL USES

Environmental
Agriculture
Drinking Water
Industrial
Recreational

CALFED
BAY-DELTA
PROGRAM

CALFED/123

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Executive Summary

The objective of the CALFED Water Quality Program is to provide good water quality for environmental, agricultural, drinking water, industrial, and recreational beneficial uses.

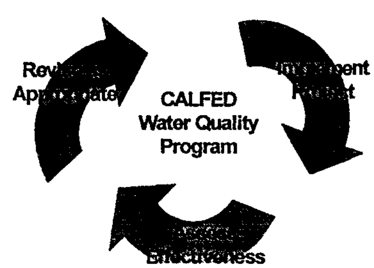
OVERVIEW

The mission of the CALFED Bay-Delta Program is to develop a long-term comprehensive plan that will restore ecosystem health and improve water management for beneficial uses of the Bay-Delta System. The Program consists of five components that address problems associated with ecosystem restoration, water quality, system integrity, water use efficiency, and water supply reliability.

All components of the CALFED Program, are being developed and evaluated at a programmatic level. The complex and comprehensive nature of a Bay-Delta solution means that it will necessarily be composed of many different programs, projects, and actions, that will be implemented over time. During the current phase of the Program, solution alternatives will be evaluated as sets of programs and projects so that broad benefits and impacts can be identified. In the next phase of the Program, more focused analysis, environmental documentation, and implementation of specific programs and actions will occur.

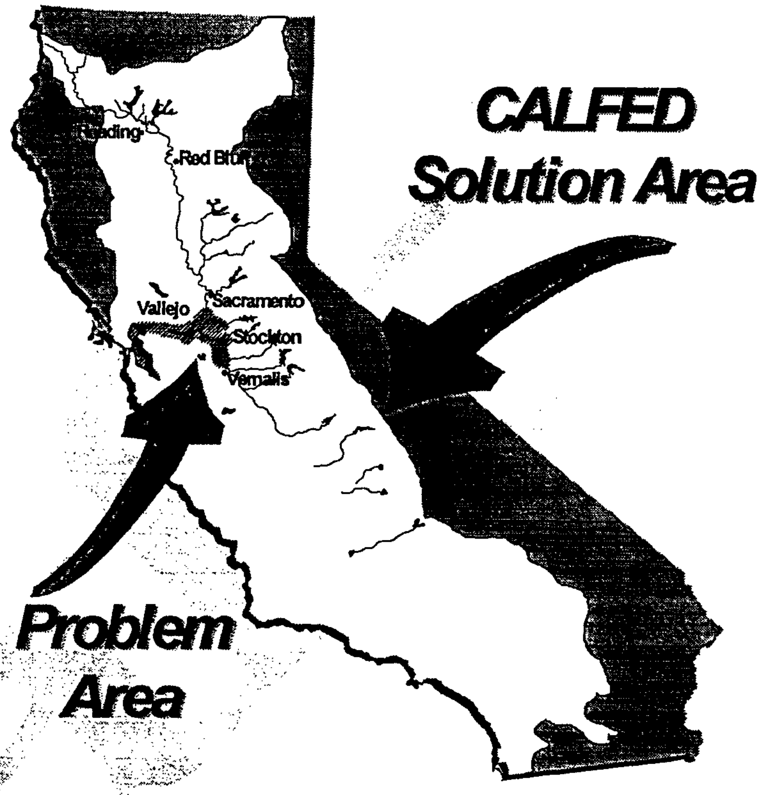
Water Quality Component

CALFED's objective for water quality is to provide good water quality for urban, agricultural, industrial, environmental, and recreational beneficial uses. This objective will be achieved through development and implementation of the CALFED Water Quality Program (WQP). The WQP will recommend action strategies that address identified parameters of concern to beneficial uses. These action strategies will have measurable performance targets and indicators of success that will be used to judge program effectiveness and facilitate adaptive management.



Adaptive Management Cycle

Geographic Scope of Water Quality Program



The geographic focus of the WQP is the Delta, which has been identified as the primary "problem" area by CALFED. This area consists of the legally defined Delta, Suisun Bay to Carquinez Strait, and Suisun Marsh. Some species (e.g., anadromous fish) that inhabit the Delta are impacted by conditions outside the Delta. Also, areas outside the Delta are sources of water quality problems affecting the Delta, its inhabitant species, and users of Delta water. In resolving the water quality problems of the Delta, the WQP recommends that actions be taken throughout the geographic solution area, as necessary.

WATER QUALITY COMPONENT REPORT

The Water Quality Component Report defines the basic structure of the WQP including:

- beneficial use water quality issues,
- water quality parameters of concern to beneficial uses,
- sources and loadings of parameters of concern,
- water quality beneficial use problem areas,
- existing programs to address parameters of concern,
- CALFED recommended action strategies,
- a monitoring and assessment framework to and evaluate action effectiveness, and
- a description of how CALFED's water quality activities may be coordinated with ongoing watershed management activities.

In addition to defining the CALFED Water Quality Program information from the Water Quality Component Report will be used to assess impacts as part of the CALFED Programmatic EIS/EIR process. Following is a summary of the main components of the Water Quality Component Report.

Selecting Parameters of Concern

The CALFED Water Quality Program has accessed and utilized a large group of water quality technical experts to assist in the development of the Water Quality Program. These stakeholders, known as the Water Quality Technical Group, represent federal, state and local agencies, environmental advisory groups, industry, (pesticide, mining, etc.), agriculture, recreation, urban water supply, and watershed interests.

Initially, three technical teams of stakeholders were formed to identify the source water quality requirements of the ecosystem, urban and agricultural water users. The ecosystem team was primarily comprised of federal and state agency representatives (California Department of Fish and Game, US Fish and Wildlife Service, US Environmental Protection Agency, California Departments of Fish and Game and Pesticide Regulation, US Fish and Wildlife Service and Environmental Protection Agency, and State and Region 2 and 5 Water Quality Control Boards). The urban team included both agency staff and urban water agency representatives. The agricultural team was represented by agency staff, farmers, and agricultural water suppliers. Using available data and technical knowledge the teams identified "parameters of concern" that were of concern to their beneficial use of water. The teams also identified actions that might be taken to reduce these parameters. CALFED then invited additional stakeholders to join in the process, specifically those who might be impacted from implementation of the recommended water quality actions.

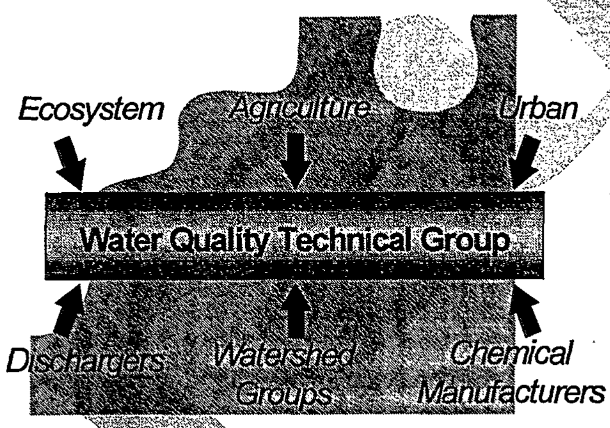


Table E-1 identifies parameters that have been identified by the Water Quality Technical Group as currently of concern to beneficial uses of water. This list may change over time in response to additional knowledge and understanding of these and other parameters.

In addition to the technical workgroup meetings CALFED has held workshops to inform the general public about the water quality program's activities. CALFED staff have also met with a variety of groups including the Clean Water Caucus, California Water Environment Association, and the California Urban Water Agencies. The CALFED Bay Delta Advisory Committee has been kept appraised of the water quality program's progress through informational segments at their regularly scheduled meetings.

Table E-1 Parameters of Concern to Beneficial Uses

Environmental		Drinking Water	Agriculture	Recreational	Industrial
Metals&Toxic Elements Cadmium Copper Mercury Selenium Zinc **Organics/Pesticides** Carbofuran Chlordane Chlorpyrifos DDT Diazinon PCBs Toxaphene	**Other** Ammonia Dissolved Oxygen Salinity (TDS, EC) Temperature Turbidity Unknown Toxicity*	**Disinfection By-Product Precursors** Bromide TOC **Other** Pathogens Turbidity Salinity (TDS) Nutrients (Nitrate) pH	**Other** Boron Chloride Nutrients (Nitrate) pH (Alkalinity) Salinity (TDS, EC) SAR Turbidity Temperature	**Metals** Mercury **Organics/Pesticides** PCBs DDT **Other** Pathogens Nutrients	**Other** Salinity pH Alkalinity Phosphates Ammonia

*Unkown toxicity refers to observed aquatic toxicity the source of which is unknown.

Impacts to Beneficial Uses of Water

Drinking Water

The Delta is a source of drinking water for about 20 million, or two-thirds, of all Californians. Beneficial use of drinking water can be impacted by loadings of bromide, nutrients, salinity, organic carbon, turbidity, pathogens or changes in pH. Pathogens such as *Cryptosporidium parvum* in source water can adversely affect municipal drinking water supplies. Nutrient loading, and subsequent algae blooms, can impair the taste and odor of municipal water supplies and increase the expense of treating the water. Elevated turbidity due to suspended solids can be responsible for increasing treatment costs for municipal water supplies.

A major problem during periods of low Delta outflows is tidal mixing of salt into the Delta channels. Salts are a major concern with regard to municipal drinking water supplies because of the presence in sea water of bromide, which contributes to unwanted disinfection byproducts (DBPs). Salt can result in aesthetic problems such as salty taste, corrosion of appliances, plumbing and industrial facilities, and reduced opportunity for waste water recycling. Salts also are present in freshwater inflows to the Delta due to municipal and agricultural discharges. The most heavily concentrated sources of agricultural drainage to the Delta is the San Joaquin River.

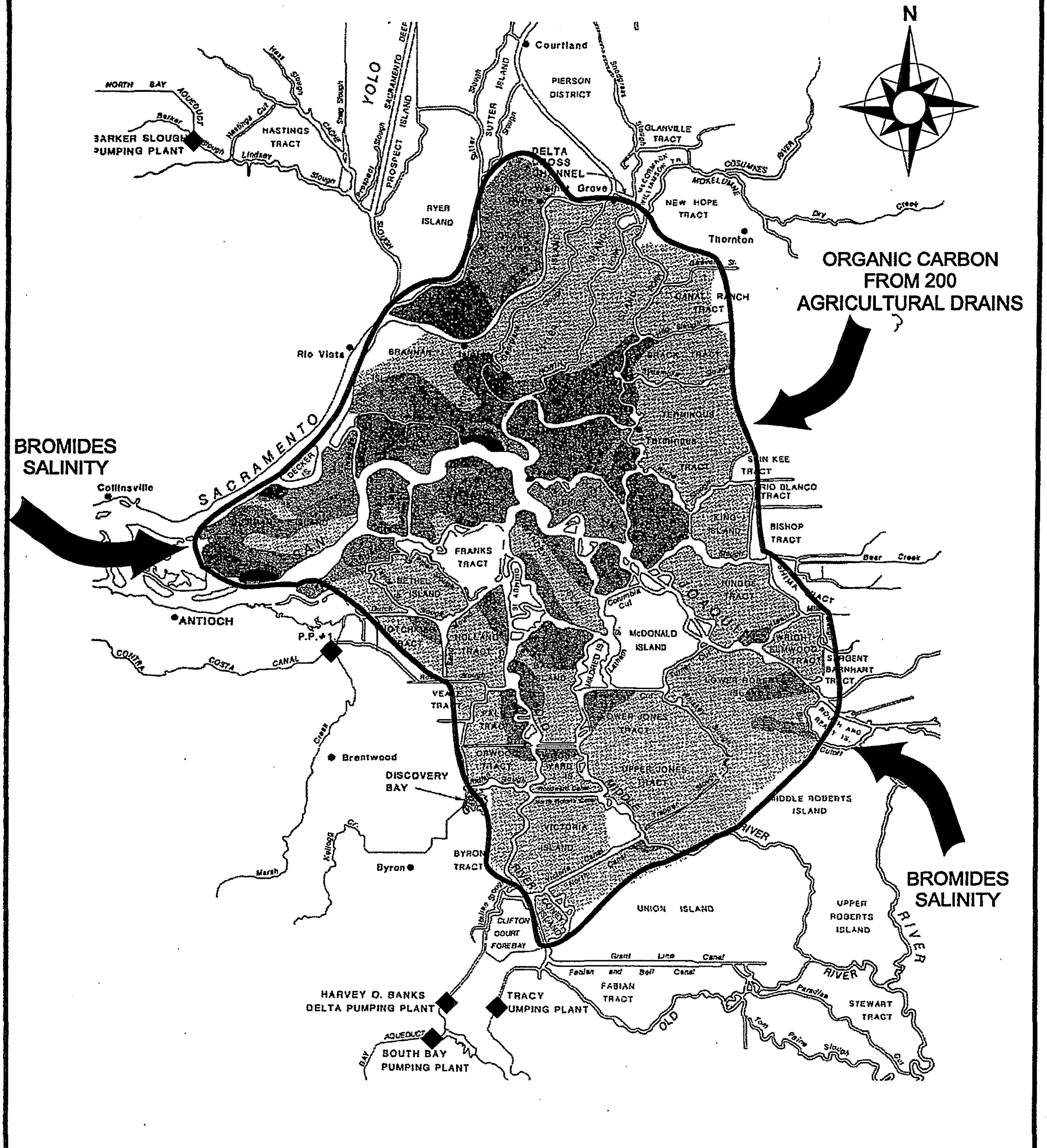
Organic carbon in source water can adversely affect municipal drinking water supplies by combining with water treatment disinfectants to produce harmful by-products such as trihalomethanes. Of particular concern to drinking water is agricultural drainage from Delta Islands because the peat soils of the Delta contribute organic carbon to the agricultural drainage water. Delta diversions through the State Water Project H.O. Banks and North Bay

Pumping Plants, the Central Valley Project Tracy Pumping Plant, and the Contra Costa Water District Pumping Plant at Rock Slough supply water for municipal purposes. Figure E-1 depicts the interaction between municipal water intakes located in the Delta and sources of bromides, salinity and organic carbon.

Agriculture
More than 1,800 agricultural diversions are located within the Delta. These diversions supply irrigation water to over 450,000 acres of fertile Delta farmlands. Irrigation water destined for use on millions of acres in the San Joaquin Valley and Southern California is also diverted in the Delta at the same intakes used for municipal water diversion. Beneficial uses of water by agriculture can be impacted by loadings of boron, salts, nutrients, pH, sodium absorption ratios, and turbidity. Excess salts can result in plant toxicity and negative effects on plant growth and crop yield.. Salts affect the ability of a plant to take up water. Salts coupled with a disproportionate amount of sodium in the water, can cause the soil surface to seal, limiting water infiltration. Excessive vegetative growth or delayed crop maturity can result from excessive nutrients and white deposits on fruit or leaves can occur due to sprinkling with high pH water. Turbidity and nutrients can also foul irrigation systems.

Environment
The Delta is the West Coast's largest estuary, one of the country's largest systems for fish production, and provides habitat for more than 120 fish species. An estimated 25 percent of all warm water and anadromous sport fishing species and 80 percent of the state's commercial fishery species either live in or migrate through the Delta. Beneficial uses of water for environmental purposes, specifically fishery resources, have been impacted due to toxic pollutants such as trace metals and synthetic organic compounds. Also, nutrients, pathogens, pH, dissolved oxygen and temperature have the potential to affect Delta species. Populations of striped bass and other species have declined significantly from historical levels. Causes of the declines are uncertain, although water quality conditions in the Bay and Delta, decreases in Delta inflow and outflow rates, habitat loss, agricultural and other instream diversions, and in-Delta exports are thought to be contributing factors. Metals, pesticides, salts, and ammonia in elevated concentrations can be toxic to early life stages of fish and invertebrate species. Mercury can bioaccumulate in the upper levels of the food chain, affecting larger fish, birds and mammals. Pathogens can adversely affect fish either acutely (lethality) or chronically (histopathological effects, impaired reproduction). Solids can increase turbidity in water bodies, reducing photosynthesis and available food for fish. Solids can also cause siltation of water bodies, burying and ruining spawning gravels that are essential fish reproduction habitat. Nutrient loading can lead to direct or indirect (abnormal algae blooms) depletion of dissolved oxygen in water bodies, which can suffocate aquatic organisms, and lead to observable fish kills. Nutrient limitations may at times limit food availability to aquatic species.

Recreation
The Delta supports about 12 million public user days a year through a variety of recreational opportunities including fishing, camping, and boating. 120 marinas, shown in Figure E-2, are



LEGEND

◆ DRINKING WATER INTAKES

PEAT SOILS

FIGURE E-1 - LOCATION OF MUNICIPAL WATER INTAKES IN RELATION TO SOURCES OF BROMIDES, SALINITY, AND TOTAL ORGANIC CARBON

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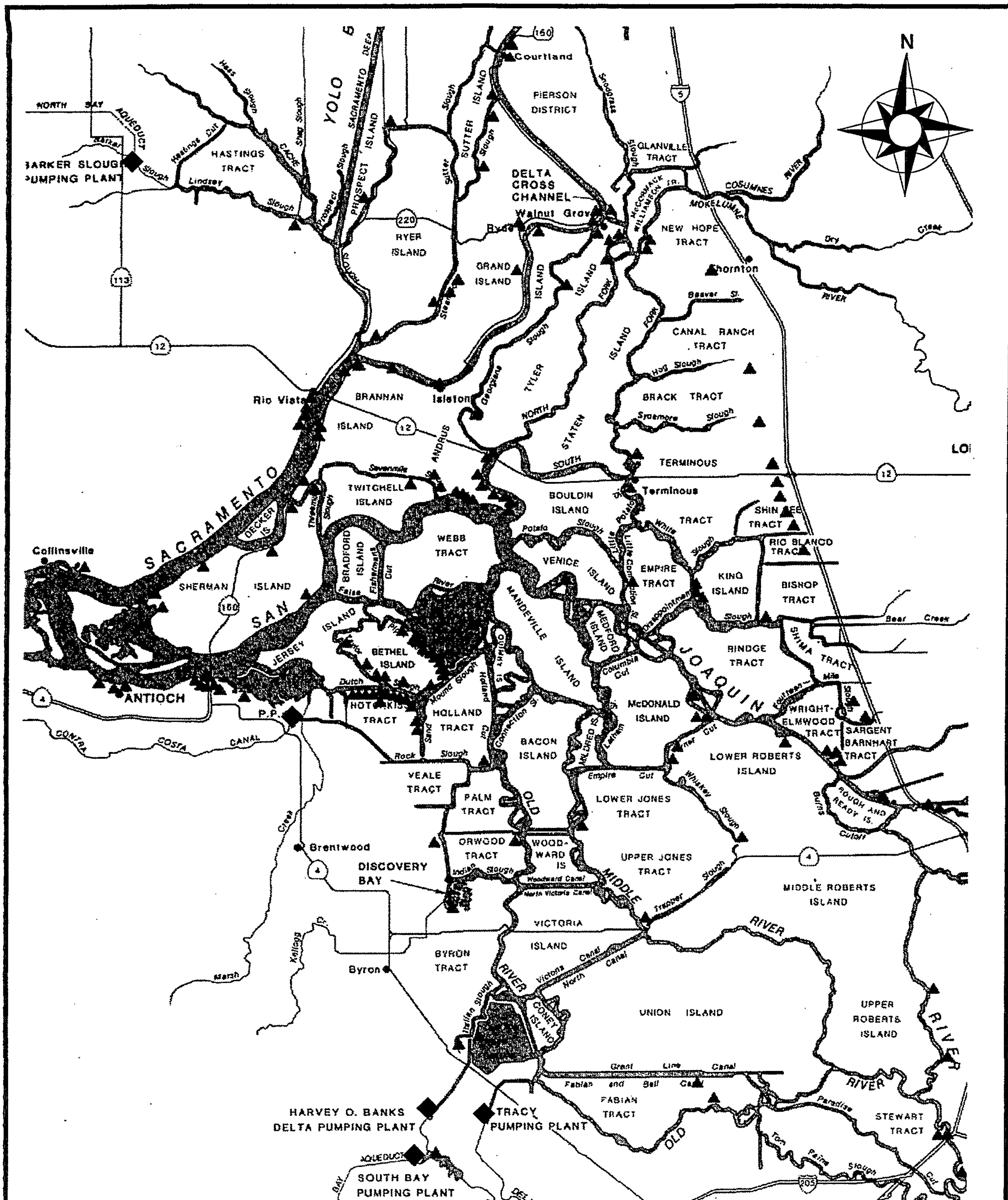


LEGEND

◆ DRINKING WATER INTAKES

▲ MARINA

FIGURE E-2 - MARINAS LOCATED IN THE DELTA

located within the Delta's boundary and approximately 82,000 boaters utilize the Delta's waterways. Recreational beneficial uses in the Delta may be affected due to pathogens, metals, pesticides, solids, or nutrients. Microbial pathogens can adversely affect the health of those who are participating in water contact recreation, such as swimming, water skiing, or windsurfing. Pathogen contamination of fish or shellfish can adversely affect public health. Certain metals and pesticides, such as mercury and DDT, bioaccumulate in the food chain and can adversely affect recreational fishers who consume contaminated fish and shellfish. Solids loading can increase the turbidity of waters and interfere with the aesthetic enjoyment of these natural resources and constitute a hazard to swimmers. Solids loading is also a mechanism by which pathogens, metals, pesticides, and nutrients are transported into waters that support recreational beneficial uses. Nutrient loading can promote algal blooms that reduce water clarity and sometimes cause unsightly, odorous floating mats and fouling of boat hulls.

Industrial
The Delta supports a wide variety of industries from sugar production to oil refineries. Industrial water is diverted directly from the Delta or conveyed through the same facilities used for municipal purposes. Some industrial processes divert water from municipal systems prior to treatment and treat the raw water to the level required for their specific industrial process. Industrial uses of water may be impaired due to salinity, phosphates, ammonia and pH. Salinity has adversely affected industrial processes such as paper manufacturing through corrosion and mineral scaling of industrial equipment. For refineries, a major user of industrial water, high concentrations of phosphates can aggravate scaling concerns in cooling water systems and high levels of ammonia can cause cracking in brass cooling heat exchangers.

Prioritizing Problem Areas

Defining what constitutes a "problem" is a controversial and debatable issue. Very few of the parameters of concern have been studied sufficiently to understand their fate, transport and impact on beneficial uses of water. If a parameter is measured against an existing objective, criteria or standard a decision must be made 1) whether the standard is appropriate, 2) what the standard is meant to protect, and 3) what level of exceedance is relevant (e.g., duration, season, geographic location, etc.). For example, an exceedance of copper in the Upper Sacramento River during the fall-run chinook salmon juvenile outmigration period might be devastating to the population however, during other times of the year (when fall-run are not present) there may be virtually no biological impact. For some parameters such as temperature and salinity extensive data has been collected. For other parameters such as pesticides minimal information is known. Given the inherent difficulties in attempting to measure data against published standards the Water Quality Program has adopted the following approach to identifying and prioritizing beneficial use problem areas.

- For environmental and recreational beneficial uses, problem areas are primarily designated based on Section 303(d) of the Clean Water Act. This Act requires each state to develop a list, known as a 303(d) list, of water bodies that are impaired with respect to water quality and to identify the sources of impairment (e.g., mine drainage, agricultural drainage, urban and industrial runoff, and municipal and industrial wastewater discharges). Water bodies impaired by CALFED water quality parameters of concern are shown in Figure E-3.

- For drinking water beneficial uses, problem areas are determined based on the suitability of Delta drinking water sources to be treatable, at reasonable cost, to meet current and future federal and State health-based drinking water standards.
- For agricultural beneficial uses, problem areas are determined according to the impact of irrigation source water on sustainable productivity of agricultural lands.
- In addition a problem area can be defined based on scientific studies and data that indicate a potentially significant problem exists.

Identifying Sources of Problems

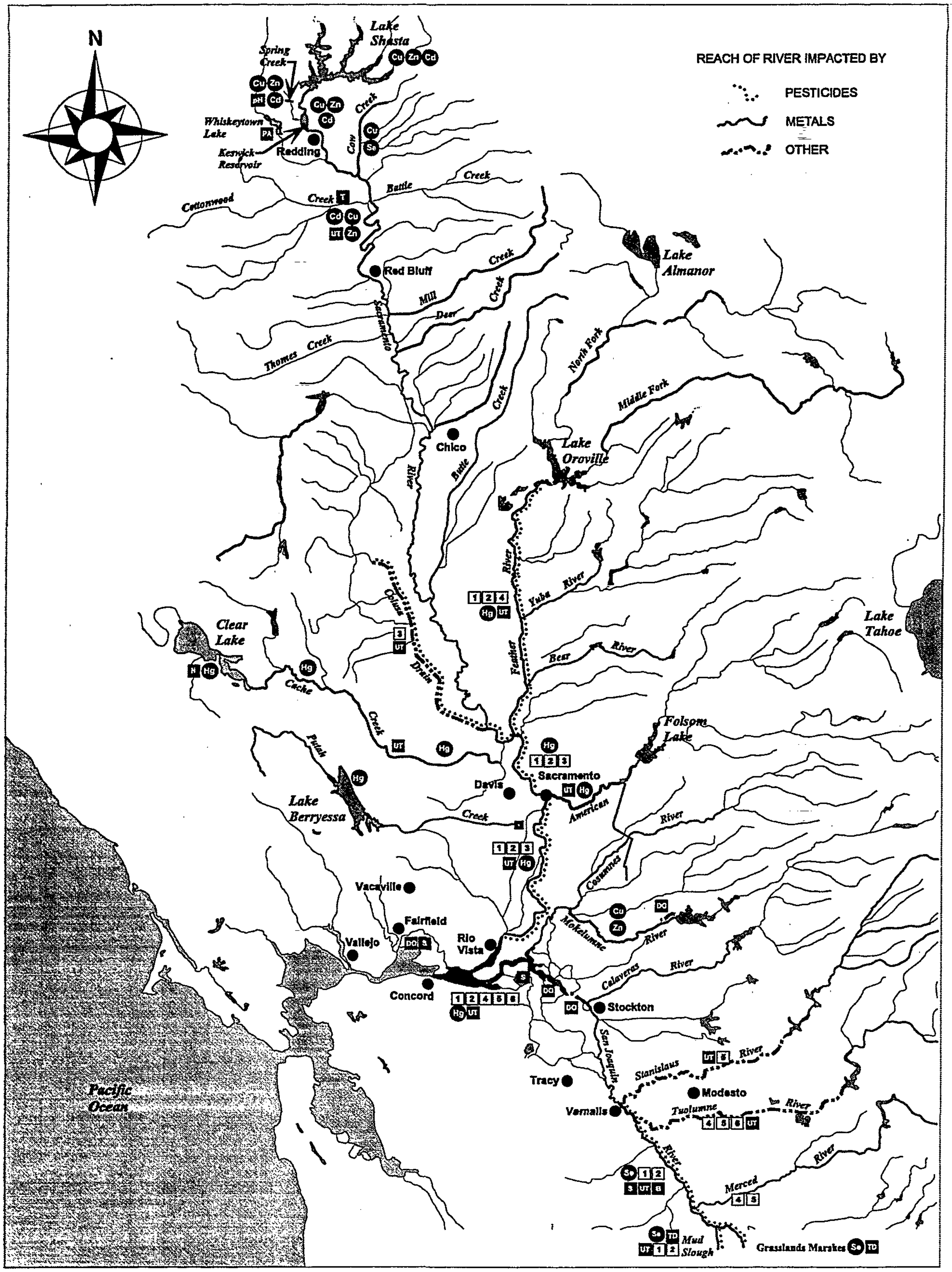
To effectively take action to improve water quality conditions it is not sufficient to only know where a problem exists in a water body, the source of the water quality problem must also be identified. Sources of water quality parameters of concern in the Delta and its tributaries include:

- acidic drainage from inactive and abandoned mines that introduce metals such as cadmium, copper, zinc, and mercury;
- stormwater inflows and urban runoff that may contribute metals, selenium, turbidity, pathogens, organic carbon, nutrients, pesticides, petroleum and other chemical residues;
- municipal and industrial discharges that may contribute salts, metals, trace elements, nutrients, pathogens, chemical residues, oil and grease, and turbidity;
- agricultural tail water, or return flows, that may contribute salts, nutrients, pesticide residues, pathogens, and turbidity; and,
- subsurface agricultural drainage that may contribute salts, selenium and other trace elements, nutrients, and pesticides (some fungicides).

The general locations of the major sources of water quality parameters of concern are shown in Figure E-4.

Developing Action Strategies

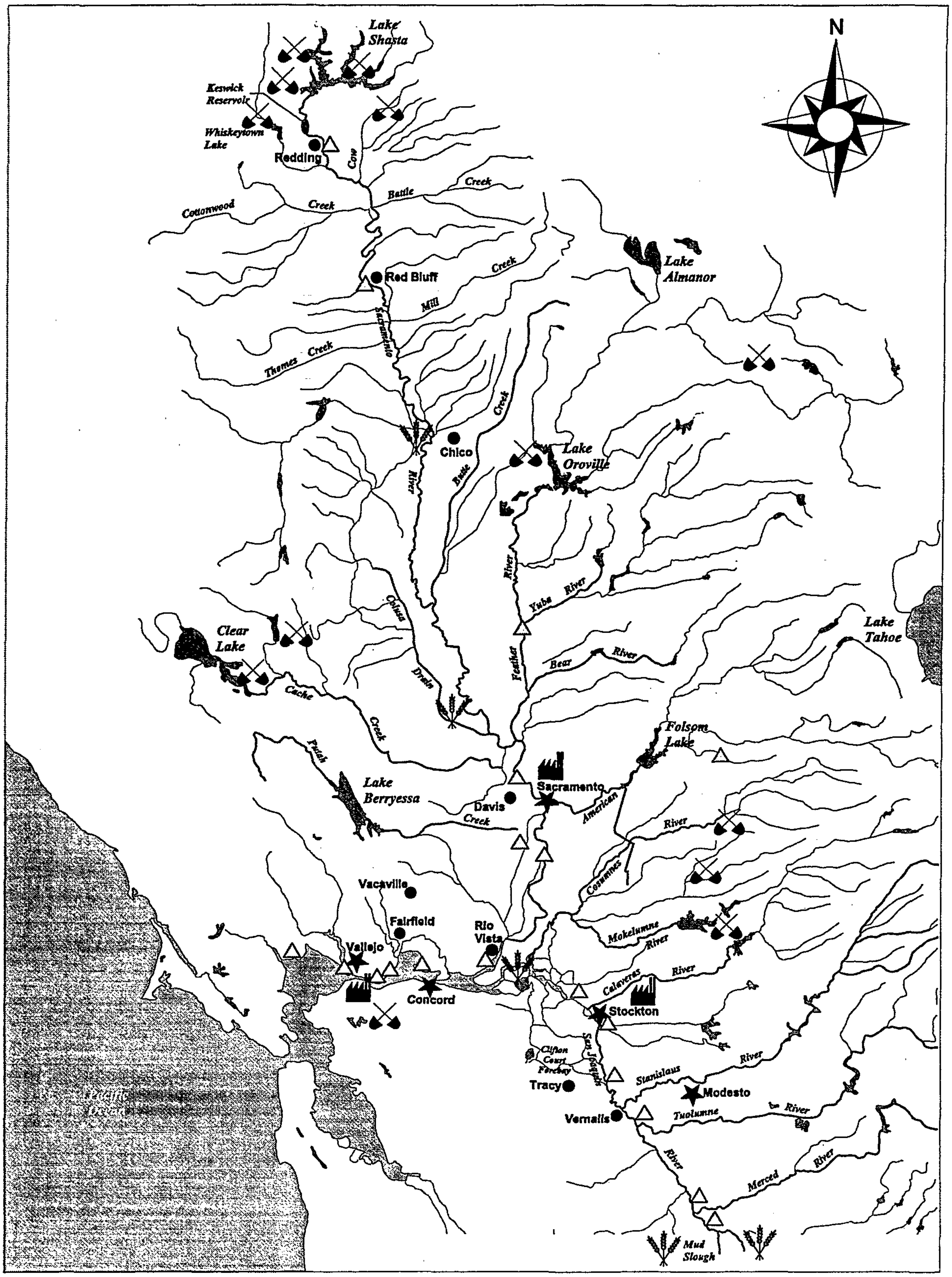
Action strategies have been developed to address water quality parameters of concern in the Delta and its tributaries. The strategies are recommended actions that will result in improvements to source water quality by reducing source loadings of parameters (e.g., mine drainage, agricultural drainage, urban and industrial runoff, and municipal and industrial wastewater treatment facilities); upgrading water treatment plants; or changing water management practices.



PARAMETERS OF CONCERN

TRACE ELEMENTS	PESTICIDES	OTHER	
Hg MERCURY	1 DIAZINON	DO DISSOLVED OXYGEN	N NITRATE
Cu COPPER	2 CHLORPYRIFOS	PA PATHOGENS	T TEMPERATURE
Zn ZINC	3 CARBOFURAN	TD TDS	S SALT
Se SELENIUM	4 TOXAPHENE	pH pH	B BORON
Cd CADMIUM	5 DDT, 6 CHLORDANE	UT UNKNOWN TOXICITY	

FIGURE E-3 - CALFED IMPAIRED WATER BODIES BASED ON CWA SECTION 303(D) LIST



LEGEND

WASTEWATER TREATMENT PLANT	AGRUCULTURAL DRAINS
CITIES UNDER 100K POPULATION	INDUSTRIAL FACILITIES
CITIES OVER 100K POPULATION	MINE - INACTIVE OR ABANDONED

FIGURE E-4 - POTENTIAL SOURCES OF PARAMETERS OF CONCERN

Action strategies to address water quality parameters of concern include a combination of research, pilot studies and full-scale actions. For some parameters, such as mercury, there is inadequate understanding about its sources, the bioavailability of the various sources, and the load reductions needed to reduce fish tissue concentrations to levels acceptable for human consumption. For this parameter further study is recommended before full-scale actions are taken. For other parameters, such as selenium, sources are better documented, and source control or treatment actions can be taken with a reasonable expectation of positive environmental results.

Performance targets have been established to measure the effectiveness of actions to improve water quality. Performance targets may be quantifiable reductions in loadings of parameters. For example, the target for copper in the Sacramento River is to reduce copper loadings in the Upper Sacramento River from 65,000 pounds to 10,000 pounds per year. For actions that recommend further study of a parameter the performance target may be a focussed outcome. For example, an action for mercury is further research to better understand the sources and mechanisms of mercury accumulation in the Delta estuary. The performance target is a targeted action plan that specifies selection and prioritization of the most effective mercury remediation actions.

Indicators of success are generally numerical or narrative water quality targets, or biological indicators, that have been developed for each parameter of concern. Targets relate to in-stream, sediment, or tissue concentrations of parameters. They will be used to gauge action and alternative effectiveness at protecting beneficial uses. Targets are based on Water Quality Control Plans (Basin Plans) of the Bay Area and Central Valley Regional Water Quality Control Boards or U.S. Environmental Protection Agency ambient water quality objectives (when available), standard agricultural water quality objectives, and target source drinking water quality ranges as defined by technical experts. Some parameters, such as pathogens have no regulatory objectives. In these cases indicators of success are generally a quantifiable reduction in counts before and after action is taken.

Table E-2 summarizes the Action Strategies for each parameter of concern included in the CALFED Water Quality Program.

Comprehensively Conducting Monitoring, Assessment and Research

The Water Quality Program, and indeed all CALFED activities, must be based on the application of rigorous science. While there is some information on the existence of water quality problems in the CALFED solution area, much is yet to be learned. CALFED is developing a Comprehensive Monitoring, Assessment, and Research Program (CMARP) to address the need for adequate scientific support not only in the water quality area, but also for the system integrity, ecosystem restoration, and water supply reliability resource areas. The CMARP is central to the CALFED philosophy of adaptive management. The water quality component of the CMARP will provide for:

- Establishing a quality assurance/quality control plan to assure the scientific validity of CALFED data collection included in this plan will be recommendations for standardized data collections and handling practices to assure that all data collected for CALFED are compatible;

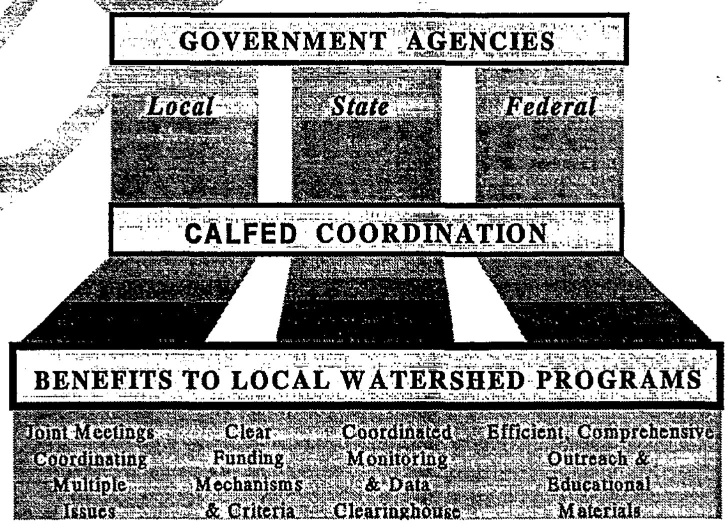
- Establishing the actual existence and severity of water quality problems, including evaluating the ecosystem effects of water quality parameters;

- Establishing baseline water quality conditions against which the effectiveness of CALFED actions will be measured; and,

- Evaluating the effectiveness of CALFED water quality improvement actions and identifying the need for adaptive management actions.

Coordinating Watershed Activities

CALFED may work with local agencies to assist in the formation of alliances and cooperative projects to improve water quality for beneficial uses on a larger scale than might be possible with local agencies working alone or in more narrowly scoped programs. CALFED's system-wide watershed focus on water quality will help to better integrate and coordinate State/Federal resource management programs with local watershed activities, while ensuring long-term benefits for the Bay-Delta estuary.

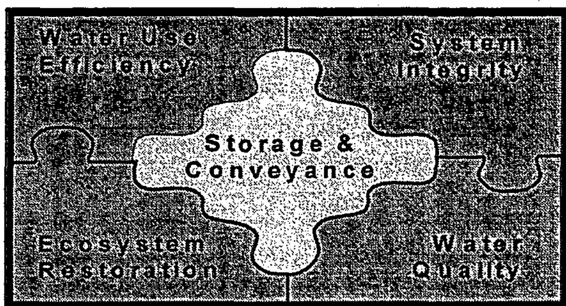


CALFED activities are being coordinated with existing or new watershed management programs affecting the Bay-Delta system including, but not limited to, the Sacramento River Watershed Program, the San Joaquin Valley Drainage Implementation Program, the San Francisco Estuary Project Comprehensive Conservation and Management Plan and the federal, State, and Regional Water Quality Control Board's Watershed Management Initiative Programs.

SECTION 1

INTRODUCTION

The mission of the CALFED Bay-Delta Program (Program) is to develop a long-term comprehensive plan that will restore ecosystem health and improve water management for beneficial uses of the Bay-Delta System. The Program addresses problems in five resource areas: ecosystem restoration, water quality, system integrity, water use efficiency and water supply reliability (i.e., storage and conveyance). The report that follows details the plans associated with the water quality component of this Program.



All components of Bay-Delta solution alternatives, are being developed and evaluated at a programmatic level. The complex and comprehensive nature of a Bay-Delta solution means that it will necessarily be composed of many different programs, projects, and actions, that will be implemented over time. During the current phase of the Program, solution alternatives will be evaluated as sets of programs and projects so that broad benefits and impacts can be identified. In the next phase of the Program, more focused analysis, environmental documentation, and implementation of specific programs and actions will occur.

Water Quality Program

The objective of the Water Quality Program (WQP) is to ensure that good water quality can be provided for urban, agricultural, industrial, environmental, and recreational beneficial uses.

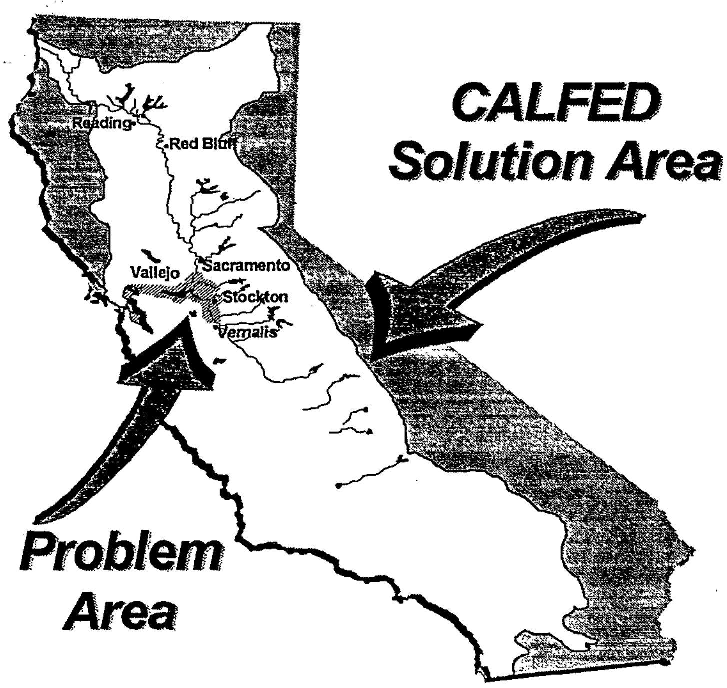
The water quality objective will be achieved through development and implementation of a prioritized set of water quality actions that address identified parameters that are of concern to beneficial uses. These actions will have measurable performance targets and indicators of success that will be used to judge program effectiveness and facilitate adaptive management. Adaptive management is a process of testing alternative ways of meeting objectives, and adapting future management actions according to what is learned.

In developing the WQP the six CALFED solution principles were taken into account. These principles state that a Bay-Delta solution must:

- *Reduce Conflicts in the System*
  Solutions will reduce major conflicts among beneficial users of water.
- *Be Equitable*
  Solutions will focus on solving problems in all problem areas. Improvements for some problems will not be made without corresponding improvements for other problems.
- *Be Affordable*
  Solutions will be implementable and maintainable within the foreseeable resources of the Program and stakeholders.
- *Be Durable*
  Solutions will have political and economic staying power and will sustain the resources they were designed to protect and enhance.
- *Be Implementable*
  Solutions will have broad public acceptance and legal feasibility, and will be timely and relatively simple to implement compared with other alternatives.
- *Have No Significant Redirected Impacts*
  Solutions will not solve problems in the Bay-Delta system by redirecting significant negative impacts, when viewed in their entirety, within the Bay-Delta or to other regions of California.

Geographic Scope of CALFED Water Quality Program

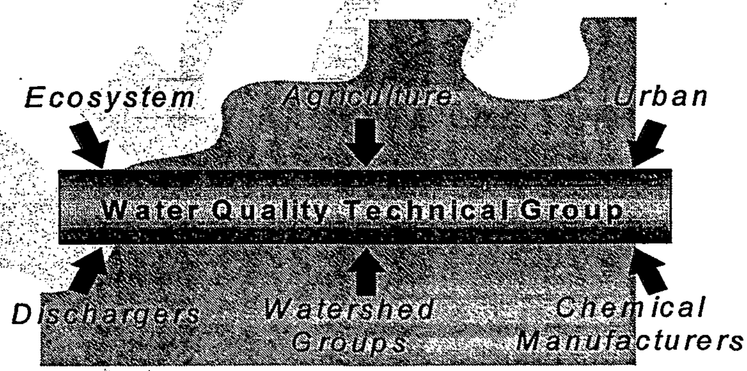
The geographic focus of the WQP is the Delta, which has been identified as the primary "problem" area by CALFED. This area consists of the legally defined Delta, Suisun Bay to Carquinez Strait, and Suisun Marsh. Some species (e.g., anadromous fish) that inhabit the Delta are impacted by conditions outside the Delta. Also areas outside the Delta are sources of water quality problems affecting the Delta, its inhabitant species, and users of Delta water. In resolving the water quality problems of the Delta, the WQP has recommended actions be taken throughout the geographic solution area, as necessary.



Stakeholder Involvement

The CALFED Water Quality Program has accessed and utilized a large group of water quality technical experts to assist in the development of the Water Quality Program. These stakeholders, known as the Water Quality Technical Group, represent federal, state and local agencies, environmental advisory groups, industry (e.g., pesticide, mining, etc.), agriculture, recreation, urban water supply, and watershed interests.

Initially, three technical teams of stakeholders were formed to identify the source water quality requirements of environment, urban and agriculture water users. The environment team was primarily comprised of federal and state agency representatives (California Department of Fish and Game, US Fish and Wildlife Service, US Environmental Protection Agency, California Departments of Fish and Game and Pesticide Regulation, US Fish and Wildlife Service and Environmental Protection Agency, and State and Region 2 and 5 Water Quality Control Boards). The urban team included both agency staff and urban water agency representatives. The agriculture team was represented by agency staff, farmers, and agricultural water suppliers. Using available data and technical knowledge the teams identified parameters that were of "concern" to their respective beneficial use of water and actions that might be taken to reduce these parameters. CALFED then invited additional stakeholders to join in the process. The stakeholders included those who might be impacted from implementation of the recommended water quality actions (e.g. parties responsible for mine drainage, agricultural drainage, urban runoff, wastewater and industrial discharges, etc.) and representatives of environment and watershed interests.



In addition to the technical workgroup meetings CALFED has held workshops to inform the general public about WQP activities. CALFED staff have met with a variety of groups including the Clean Water Caucus, California Water Environment Association, and the California Urban Water Agencies. The CALFED Bay Delta Advisory Committee has been kept appraised of the WQP's progress through informational segments at their regularly scheduled meetings.

Stakeholder involvement in CALFED water quality activities is planned to continue throughout the life of the CALFED effort. A list of the Water Quality Technical Group stakeholders can be found in Appendix A.

Structure of Report

The Water Quality Component Report that follows discusses:

- beneficial use water quality issues,
- water quality parameters of concern to beneficial uses,
- sources and loadings of parameters of concern,
- water quality beneficial use problem areas,
- existing programs to address parameters,
- CALFED recommended action strategies to address parameters,
- a monitoring and assessment framework to evaluate effectiveness of the WQP,
- a description of how this program will be coordinated with ongoing watershed management activities.

Additional information pertaining to the Water Quality Program can be found in the Water Quality Component Report Appendices and the CALFED Water Quality Supplemental Information document.

SECTION 2

BACKGROUND

The Central Valley is drained by the Sacramento River system to the north and the San Joaquin River system to the south. These two river systems converge into the Delta, which encompasses approximately 680,000 acres interlaced with approximately 700 miles of waterways (Arthur and Ball, 1978). Water flows from the Delta through the Suisun, San Pablo, and San Francisco Bays to the Pacific Ocean at the Golden Gate Bridge.

The Delta supports a variety of beneficial water uses. It is the West Coast's largest estuary, one of the country's largest systems for fish production, and provides habitat for more than 120 fish species. An estimated 25 percent of all warm water and anadromous sport fishing species and 80 percent of the state's commercial fishery species either live in or migrate through the Delta. The Delta also is a source of drinking water for about 20 million, or two-thirds, of all Californians. It provides irrigation water for approximately 200 crops or 45% of the nation's produce and water supplies to major oil refineries and paper manaufacturers. The Delta supports about 12 million public user days a year through a variety of recreational opportunities including fishing, camping, and boating by 82,000 registered boaters.

Water flowing through the Delta that is not diverted by drinking water suppliers, agriculture or industries, flows to the Pacific Ocean through San Francisco Bay. Freshwater outflows prevent saline water from encroaching into the Delta and degrading water quality. Delta channel geometry, inflows into and within the Delta, and tidal flows are interdependent variables that control seawater intrusion and water quality in the Delta.

Variable hydrologic conditions, seasonal demands for water diversions, and agricultural drainage flows result in considerable fluctuations in Delta water supply and water quality conditions. Periods of high inflows that result in low salinity alternate with periods of low inflow that allow greater salinity intrusion and exaggerate water quality effects of drainage. In the Delta, the distribution of dissolved and suspended materials is influenced by complex circulation patterns that are affected by channel geometry, flow volumes, pumping for Delta agricultural operations and exports, and tidal influence from the ocean. Under average hydrologic conditions, approximately 30% of Delta inflow is used for Central Valley Project (CVP) and State Water Project (SWP) exports, 10% is diverted for local uses, 20% is used for Delta outflow requirements, and 40% is additional Delta outflow that results from winter precipitation and runoff. The CVP and SWP export pumping plants exert a considerable influence on water circulation in the Delta by creating a net flow of water from northern regions of the Delta south through Old River and Middle River. During winter, inflow volumes typically exceed the export and other requirements and the Delta outflow is sufficient to repel the force of tidal encroachment. During late summer and fall, when low inflows and high agricultural pumping rates are occurring, flows can reverse direction in the central and western Delta channels. This pattern of "reverse flow" is a concern because of the potential effects on salinity.

Delta water quality, particularly the concentration of pollutants, is strongly influenced by the operation of upstream reservoirs and diversions, including the CVP and SWP. On average, approximately 75-85% of Delta inflow is from the Sacramento River, 10-15% is from the San Joaquin River, and the eastside streams (e.g., Mokelumne, Cosumnes, and Calaveras) contribute the remainder. San Joaquin River flows are often very low in late summer and fall. In contrast, the Sacramento River, the largest tributary to the Delta, has relatively good water quality because of the large amount of dilution provided by runoff from the watershed and releases from storage reservoirs. Chemical characteristics of Delta inflows are intimately tied to land use in the upstream watershed.

Water Quality Issues

Following are some of the major water quality issues recognized to be of concern in the Delta along with water quality concerns associated with particular beneficial uses.

- High-salinity water from Suisun and San Francisco Bays intrudes into the Delta during periods of low Delta outflow. Salinity adversely affects agricultural, municipal, recreational, industrial, and environmental use of water.

- Delta exports have elevated concentrations of dissolved organic carbon (DOC) which is a disinfection by-product (DBP) precursors, and the potential for formation of brominated DBPs increases along with increases in concentrations of the precursor bromide (Br^-), which originates in seawater.

- Synthetic and natural contaminants have accumulated in Delta sediments and can bioaccumulate in fish and other aquatic organisms. Synthetic organic chemicals and heavy metals (e.g., mercury) are found in Delta fish in quantities that occasionally exceed acceptable standards for food consumption.

- Agricultural drainage in the Delta contains high levels of nutrients, suspended solids, dissolved organic carbon, salinity, and may contain traces of agricultural chemicals (pesticides). The San Joaquin River delivers water of relatively poor quality to the Delta; agricultural drainage to the river is a significant source of salts and pollutants, including selenium, boron, and pesticides.

- Historical mining activities are a source of heavy metals, including cadmium, chromium, copper, mercury, and zinc.

- Populations of striped bass and other species have declined significantly from historical levels. Causes of the declines are uncertain, although water quality conditions in the Bay and Delta (e.g., toxicity), decreases in Delta inflow and outflow rates, habitat loss, agricultural and other instream diversions, and in Delta exports are thought to be contributing factors.

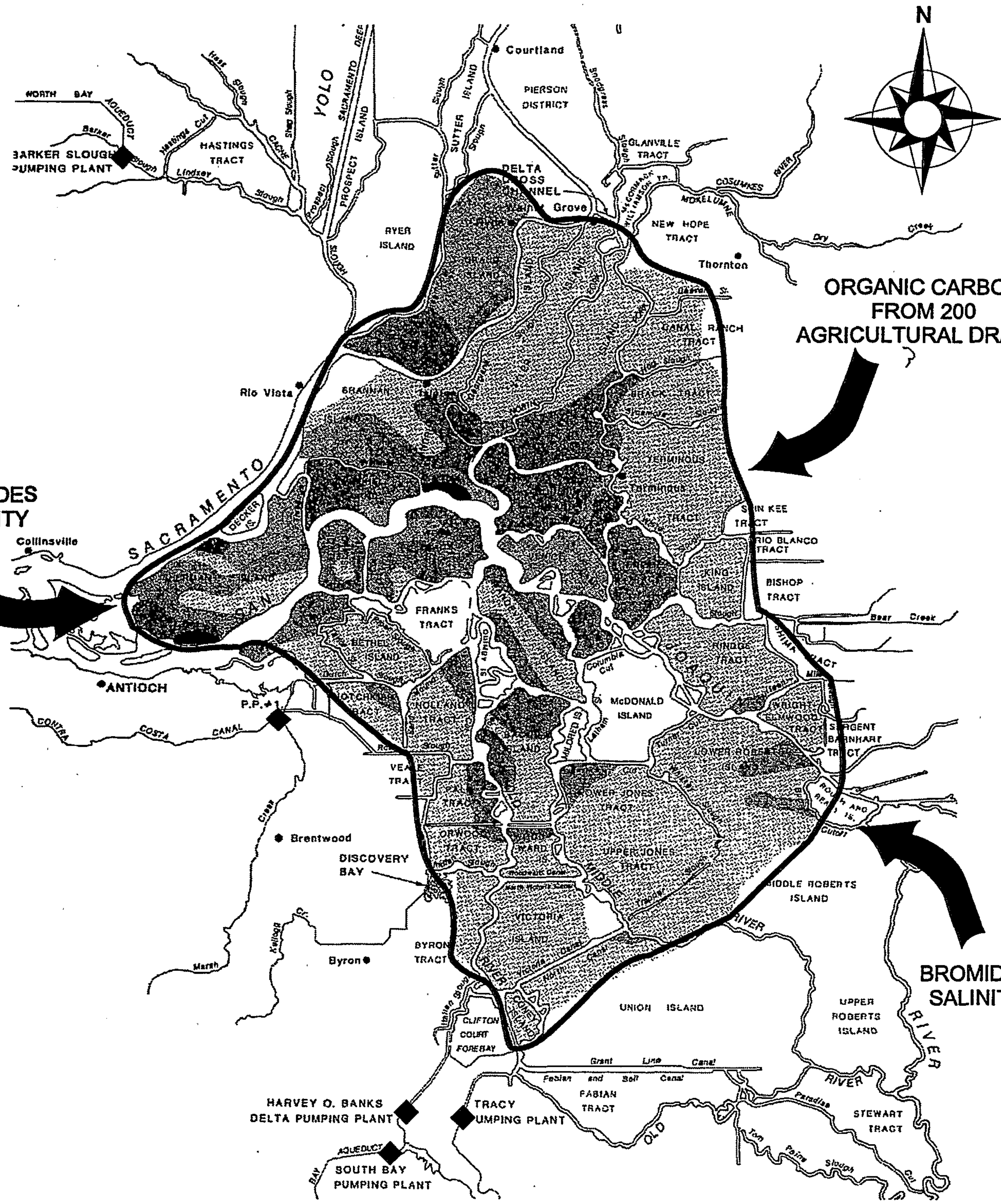
- The location of the estuarine salinity gradient and its associated "entrapment zone" (where biological productivity is relatively high because of the mixing and accumulation of suspended materials) is controlled by Delta outflow. The location of the entrapment zone affects the quantity and quality of habitat for estuarine species.

Drinking Water. Beneficial use of drinking water can be impacted by loadings of bromide, nutrients, salinity, organic carbon, turbidity, pathogens or changes in pH. Pathogens such as *Cryptosporidium parvum* in source water can adversely affect municipal drinking water supplies. Nutrient loading, and subsequent algae blooms, can impair the taste and odor of municipal water supplies and increase the expense of treating the water. Elevated turbidity due to suspended solids can be responsible for increasing treatment costs for municipal water supplies.

A major problem during periods of low Delta outflows is tidal mixing of salt into the Delta channels. Salts are a major concern with regard to municipal drinking water supplies because of the presence in sea water of bromide, which contributes to unwanted disinfection byproducts (DBPs). Salt can result salty taste, corrosion of appliances, plumbing and industrial facilities, and reduced opportunity for waste water recycling. Salts also are present in freshwater inflows to the Delta due to municipal and agricultural discharges. The most heavily concentrated sources of agricultural drainage to the Delta is the San Joaquin River.

Organic carbon in source water can adversely affect municipal drinking water supplies by combining with water treatment disinfectants to produce harmful by-products (e.g., trihalomethanes). Agricultural drainage is of particular concern to drinking water because the peat soils of the Delta contribute organic carbon to the agricultural drainage water. Delta diversions through the State Water Project H.O. Banks and North Bay Pumping Plants, the Central Valley Project Tracy Pumping Plant, and the Contra Costa Water District Pumping Plant at Rock Slough supply water for municipal purposes. Figure 2-1 depicts the interaction between sources of bromides, organic carbon and salinity and municipal water intakes.

Agriculture. Beneficial uses of water by agriculture can be impacted by loadings of boron, salts, nutrients, pH, sodium absorption ratios, and turbidity. Excess salts can result in plant toxicity and negative effects on plant growth and crop yield. Salts affect the ability of a plant to absorb water. Salts coupled with a disproportionate amount of sodium in the water can cause the soil surface to seal, limiting water infiltration. Excessive vegetative growth or delayed crop maturity can result from excessive nutrients and white deposits on fruit or leaves can occur due to sprinkling with high pH water. Turbidity and nutrients can foul irrigation systems. More than 1,800 agricultural diversion are located within the Delta. These diversions are shown in Figure 2-2. Irrigation water destined for use on millions of acres in the San Joaquin Valley and Southern California is

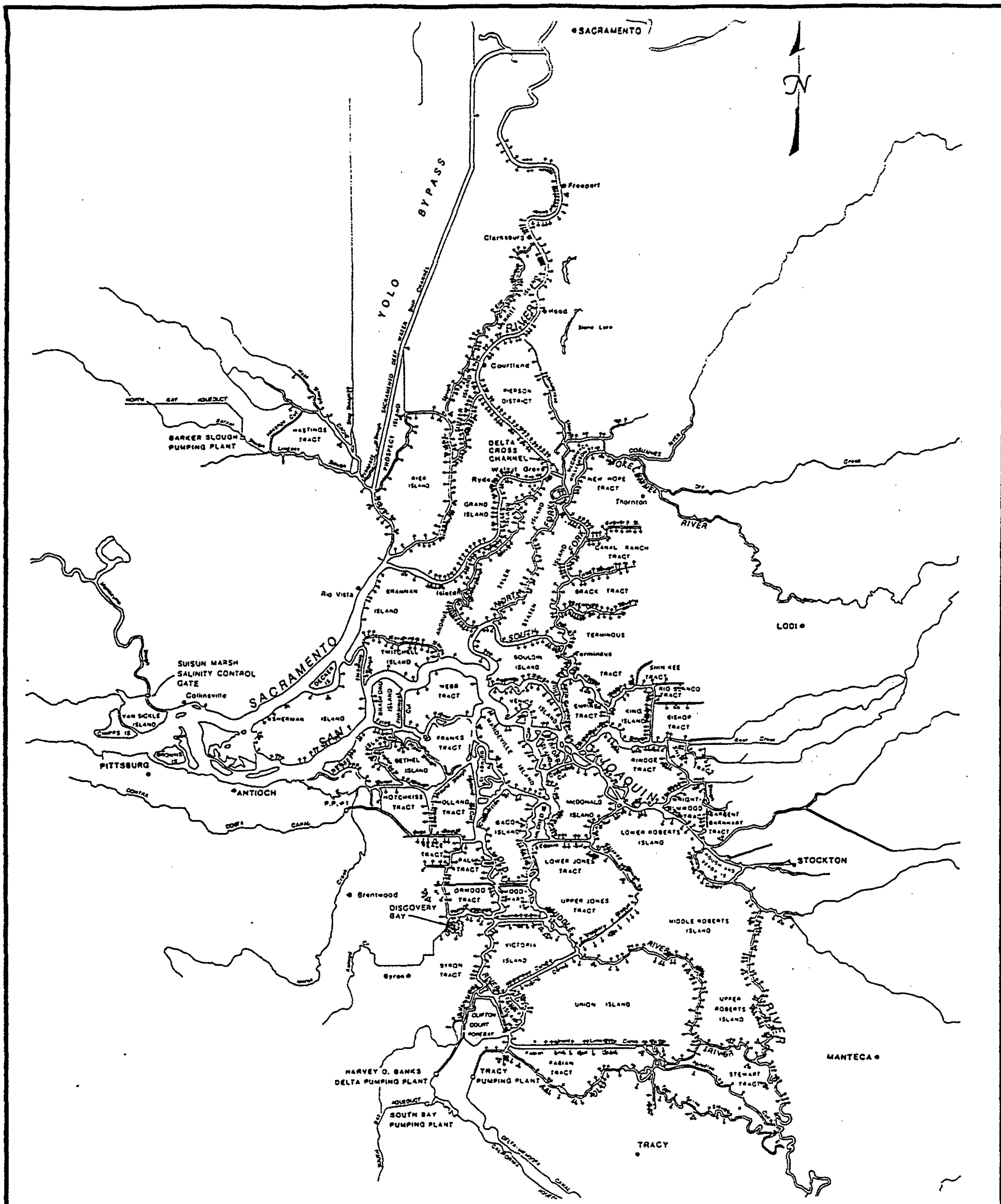


LEGEND

◆ DRINKING WATER INTAKES

PEAT SOILS

FIGURE 2-1 - LOCATION OF MUNICIPAL WATER INTAKES IN RELATION TO SOURCES OF BROMIDES, SALINITY, AND TOTAL ORGANIC CARBON



LEGEND

— Diversions (Siphons, Pumps and Floodgates). Each Arrow Represents One or More Diversion Points.

Note: Survey Conducted 1986-87 by G. Sato et al.

FIGURE 2-2 AGRICULTURE DIVERSIONS

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diverted through the Harvey O. Banks and Tracy Pumping Plants.

Environment. Beneficial uses of water for environmental purposes, specifically fishery resources, have been impacted due to toxic pollutants such as trace metals and synthetic organic compounds. Also, nutrients, pathogens, pH, dissolved oxygen and temperature have the potential to affect Delta species. Populations of striped bass and other species have declined significantly from historical levels. Causes of the declines are uncertain, although water quality conditions in the Bay and Delta, decreases in Delta inflow and outflow rates, habitat loss, agricultural and other instream diversions, and in-Delta exports are thought to be contributing factors. Metals, pesticides, salts, and ammonia in elevated concentrations can be toxic to early life stages of fish and invertebrate species. Mercury can bioaccumulate in the upper levels of the food chain, affecting larger fish, birds and mammals. Pathogens can adversely affect fish either acutely (lethality) or chronically (histopathological effects, impaired reproduction). Solids can increase turbidity in water bodies, reducing photosynthesis and available food for fish. Solids can also cause siltation of water bodies, burying and ruining spawning gravels that are essential fish reproduction habitat. Nutrient loading can lead to direct or indirect (abnormal algae blooms) depletion of dissolved oxygen in water bodies, which can suffocate aquatic organisms, and lead to observable fish kills. Nutrient limitations may at times limit food availability to aquatic species.

Recreation. Recreational beneficial uses in the Delta may be affected due to pathogens, metals, pesticides, solids, or nutrients. Microbial pathogens can adversely affect the health of those who are participating in water contact recreation, such as swimming, water skiing, or windsurfing. Pathogen contamination of fish or shellfish can adversely affect public health. Certain metals and pesticides, such as mercury and DDT, bioaccumulate in the food chain and can adversely affect recreational fishers who consume contaminated fish and shellfish. Solids loading can increase the turbidity of waters and interfere with the aesthetic enjoyment of these natural resources and constitute a hazard to swimmers. Solids loading is also a mechanism by which pathogens, metals, pesticides, and nutrients are transported into waters that support recreational beneficial uses. Nutrient loading can promote algal blooms that reduce water clarity and sometimes cause unsightly, odorous floating mats and fouling of boat hulls.

Industrial. Industrial beneficial uses of water may be impaired due to salinity, phosphates, ammonia. Salinity has adversely affected industrial processes such as paper manufacturing through corrosion and mineral scaling of industrial equipment. For refineries, a major user of industrial water, high concentrations of phosphates can aggravate scaling concerns in cooling water systems and high levels of ammonia can cause cracking in brass cooling heat exchangers. Industrial water is diverted and conveyed through the same facilities used for municipal purposes, however for many industrial purposes water is diverted and conveyed to the industrial facility prior to treatment for municipal use purposes. Industrial facilities treat raw water to the water quality required for their industrial process.

SECTION 3

PARAMETERS OF CONCERN

Parameters identified by the Water Quality Technical Group as of concern to beneficial uses of water are identified in Table 3.1. This list of parameters may change over time in response to additional knowledge and understanding of these and other parameters.

Table 3.1 Water Quality Parameters of Concern to Beneficial Uses

ENVIRONMENT	URBAN	AGRICULTURE	RECREATION	INDUSTRIAL
Metals&Toxic Elements	**Disinfection By-Product Precursors**	**Other**	**Metals**	**Other**
Cadmium	Bromide	Boron	Mercury	Salinity
Copper	TOC	Chloride	**Organics/Pesticides**	pH
Mercury	**Other**	Nutrients (Nitrate)	PCBs	Alkalinity
Selenium	Pathogens	pH (Alkalinity)	DDT	Phosphates
Zinc	Turbidity	Salinity (TDS, EC)	**Other**	Ammonia
Organics/Pesticides	Salinity (TDS)	SAR	Pathogens	
Carbofuran	Nutrients (Nitrate)	Turbidity	Nutrients	
Chlordane	pH	Temperature		
Chlorpyrifos				
DDT				
Diazinon				
PCBs				
Toxaphene				
Other				
Ammonia				
Dissolved Oxygen				
Salinity (TDS, EC)				
Temperature				
Turbidity				
Unknown Toxicity*				

* Unknown toxicity refers to observed aquatic toxicity, the source of which is unknown.

Following is a description of the parameters of concern. More detailed information on measured concentrations of parameters (water column, sediment and tissue) throughout the water quality problem area will be available in the CALFED Water Quality Affected Environment Report. Problems associated with the parameters are described in Section 6.

General Parameter Description

Metals & Toxic Elements

Heavy metals originate primarily from rocks and minerals, mining activities, and discharges of municipal and industrial wastes. Residues from heavy metals may produce serious pollution problems in the Delta because of toxic effects on fish and other aquatic organisms and may bioaccumulate in biological tissues. These residues can be measured in water, soils, sediments, and organisms that inhabit Delta channels. The detection of a particular compound depends on its persistence and mobility in the environment, as well as its source characteristics. SWRCB has

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characterized cadmium, copper, mercury, and zinc as pollutants of concern because their widespread or repeated detection indicates their potential to cause adverse effects on beneficial uses in the estuary (California State Water Resources Control Board 1990).

*Cadmium, Copper and Zinc.*The Delta receives the majority of its metals loadings from historical mining activities in upstream watersheds. The sources of mining wastes along Spring Creek in the upper Sacramento River watershed contribute large loads of chromium, cadmium, copper, nickel, and zinc to the upper Sacramento River (California Department of Water Resources 1994a). The Iron Mountain Mine, in particular, contributes most of the cadmium, copper, and zinc transported in the Sacramento River. Urban and industrial runoff can also contribute significant loadings of copper and zinc. Urban runoff in the Central Valley and the Bay Area has exhibited toxicity to the test algal organism, Selanastrum. TIE studies with this species identified copper, zinc, and the herbicide diuron as causing toxicity.

*Mercury.*Large amounts of mercury were used in the processing of gold, and river flows originating in historic gold-mining areas continue to contribute mercury to Delta waterways. Natural deposits of mercury that were mined in the Cache Creek basin are suspected to contribute high loadings of mercury to Delta waters.

Mercury is of concern from an environmental and human health perspective. During a peak storm period in 1995, mercury levels at the Creek's outfall at the Yolo Bypass were measured at 695 parts per trillion. (Pers.conv. Bill Croyle, CVRWQCB) The EPA water quality criteria is 12 parts per trillion total mercury. SWRCB biennial water quality assessments list 48,000 acres of Delta waterways as impaired because of fish consumption advisories for mercury (California State Water Resources Control Board 1992, 1994). A health advisory for the consumption of striped bass from the Delta because of elevated levels of mercury in fish tissues has been in effect since the mid-1970s.

Selenium. Selenium is an inorganic constituent of soils found in alluvium derived from rocks that originate on the ocean floor. It is particularly evident in the soils of the west side of the San Joaquin River basin. Relative to irrigation water, salts containing selenium tend to concentrate by 2-5 times in agricultural drainage. Selenium is leached out of soils as a result of irrigation and concentrates further when drainage return flows are stored in surface impoundments for long periods, or when irrigated land is inadequately drained.

Selenium is primarily an environmental concern. In 1983, high rates of waterfowl death and deformity were observed in Kesterson National Wildlife Refuge and were attributed to toxic concentrations of selenium in concentrated agricultural drainage. There is continued concern over San Joaquin River selenium transport from irrigated farm lands and industrial discharges of selenium into the Delta.

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Organics/Pesticides
Residues from organic pesticides and herbicides may produce serious pollution problems in the Delta because of toxic effects on fish and other aquatic organisms and may bioaccumulate in biological tissues. Similar to heavy metals, organic pesticides are detected in a variety of sample types, depending on the persistence and mobility of the particular compound. SWRCB biennial water quality assessments list Delta waterways as impaired because of elevated levels of pesticides (California State Water Resources Control Board 1992, 1994). Most parameter concentrations in fish do not exceed standards established by the U.S. Food and Drug Administration or the National Academy of Sciences for the consumption of fish tissues. The presence of pollutants in fish demonstrates, however, that organic pesticides are bioaccumulating in the Delta food webs.

Although pesticides are rarely detected in Delta water samples, data from various monitoring programs conducted by DWR and SWRCB have shown that contamination by synthetic organic chemicals is prevalent in sediment and organisms collected throughout the Delta. The Toxic Substances Monitoring Program has routinely detected chlorinated pesticides (e.g., DDT, toxaphene, and chlordane), the pesticides most resistant to chemical breakdown, in Delta sediments and biological tissue samples. Levels of these pesticides exceed identified thresholds for risk to humans, wildlife, or the biological receptors that come in contact with the pollutants (California State Water Resources Control Board 1995b).

Chlorpyrifos and Diazinon. Toxicity Identification Evaluation (TIE) studies of urban runoff have linked observed toxicity with the presence of Chlorpyrifos and Diazinon. Urban runoff in the Central Valley and the Bay Area has exhibited acute toxicity to the test organism, Ceriodaphnia. Both of these pesticides are widely available and have been detected simultaneously in urban creeks throughout the CALFED problem and solution areas. They are found in urban creeks throughout the year, but concentrations peak during the orchard dormant spray season (Foe, 1995). Ambient monitoring and composite rainfall samples suggest that the pesticides come from both urban and agricultural sources.

Other

Boron. Boron is essential in small quantities for optimum plant growth, however, minimal exceedance of the desirable limit can result in plant toxicity problems, manifested as drying and chlorosis. Climatic and soil conditions also influence boron toxicity, with boron uptake being generally higher at lower soil pH. Sensitive crops have shown toxic effects at and below 1 mg/L (Ayers and Westcot, 1985). Exceeding this limit can result in significant loss in crop yield. Boron concentrations can be reduced by various management practices similar to those for chloride. Reclaiming boron-affected soils requires leaching the boron from the root zone.

Because boron mobility is reduced by adsorption on soil particles, removing it from the soil profile requires approximately two to three times mor leaching water than is typically required for reclaiming saline soils (Hanson, 1993). Surface waters do not usually contain boron at toxic levels. Groundwater from wells or springs can contain toxic levels, especially near geothermal areas and earthquake faults. Some areas near the Delta are underlain by groundwater with high levels of boron. The average concentration in seawater is reported as 4.5 mg/L in the form of borate (EPA, 1976).

Chloride. For agriculture the most common toxic ion encountered in irrigation water supplies is chloride. Chloride is adsorbed (or retained) only slightly on soil particles. It therefore moves readily with the soil water and is taken up by the crop, accumulating in the leaves during transpiration. At toxic levels, injury symptoms develop such as leaf burning and desiccation. Continued uptake can lead to dead tissue and is often accompanied by early leaf drop or defoliation. Uptake of chloride depends on the relationship between the ability of the crop to exclude chloride, and concentrations in the soil water. Soil-water concentrations are controlled by concentrations in irrigation water and the amount of leaching that occurs. Crop tolerance of chloride is not as well documented as crop tolerance of salinity, and quantitative yield reduction relationships have not been defined. However, in general, woody plants, such as California's fruit and nut crops, tend to be more sensitive to chloride. Crops grown under overhead sprinkler irrigation can take up chloride through foliar adsorption of irrigation water into leaves during and after irrigation events. Management for chloride includes leaching in a manner similar to salinity, more frequent irrigation, selection of more tolerant crops and blending or switching to alternative water supplies. Where foliar absorption is a problem, certain management practices have been successful in minimizing effects. Some practices may require minor changes in management, while others will require more elaborate and costly changes. Some of these practices include scheduling irrigation at night, avoiding irrigation during high winds, increasing sprinkler rotation speeds, increasing application rates and increasing droplet size. (For more information on Chloride see Disinfection By-Products).

Disinfection Byproducts in Treated Drinking Water. THM compounds formed during chlorination of DOC in drinking water contain chloroform and brominated methanes. Chloroform, when administered at high doses, has been shown to increase the risk of liver and kidney cancer in mice (National Cancer Institute 1976). The suspected carcinogenic risk to humans from THMs has led some communities to study and change their methods of disinfecting drinking water. THM levels in drinking water can be reduced by using alternatives to chlorination to treat water for human consumption (e.g., ozonation or chloramination), although other potentially harmful DBP compounds (e.g., bromate) may be formed during these disinfection processes. Disinfection itself is being more carefully regulated by EPA to avoid problems involving various pathogens (e.g., bacteria, viruses, and protozoa). Reducing DOC concentrations in raw water before disinfection with flocculation or granular-activated carbon adsorption or removal of DBPs after being formed can reduce DBP levels but may be quite expensive.

Chloride and Bromide. Most of the Delta islands are as much as 10 to 15 feet below mean tide level. Tides in the Delta not only threaten the protecting levees, but bring periodic intrusion of seawater, which mixes with the inflowing Delta freshwater. Tidal currents created by the rise and fall of sea levels modify stream flow, particularly when outflows are low or when tides are high (DWR, IDHAMP, 1989). Intruded seawater is a major source of bromide, particularly in the western Delta. Bromide is a naturally occurring salt ion (halogen) of seawater origin and reacts with disinfectants to form brominated DBPs. Thus, intrusion profoundly affects Delta water withdrawn at the Contra Costa Water District, SWP and CVP intakes.

The presence of bromide in a drinking water source complicates the disinfection process. As with chlorine, bromide forms THMs in the chlorination process and these brominated THM's are also toxic to human health. Bromide is about twice as heavy as chlorine, and the THM standard is based on weight. Hence, it takes fewer molecules of brominated THMs to exceed the drinking water standard. Another method of disinfection, ozone treatment, is also complicated by the presence of bromide because it forms bromate, another undesirable DBP. Bromide contributes substantially to the formation of DBPs in treated drinking water from the Delta. Sources of Br^- in Delta water are seawater intrusion, San Joaquin River inflow containing agricultural drainage, and possibly connate groundwater (i.e., water trapped within sedimentary rocks that is often highly mineralized). It is uncertain whether there are native bromide sources in the San Joaquin Valley, or whether bromide found in the River is a result of concentration of bromides in agricultural irrigation water taken from the Delta and returned to the Delta through the River. Bromide has been measured by the MWQI program since January 1990.

Total and Dissolved Organic Carbon. Organic materials enter the water from the following sources in the Delta in decreasing order of amounts:

- natural materials, vegetation, and organics soils;
- agriculture, as vegetative organics in drainage;
- urban runoff;
- municipal and industrial wastewater discharges;
- pesticides and herbicides.

Organic carbon is one of the primary variables that influence the potential for DBP formation. Applicable drinking water standards are based on TOC concentrations; however, most of the available data for the Delta have focused on DOC. In general, most TOC in Delta waters is present in the dissolved form. The most common DBP is THM compounds formed during chlorination of DOC in drinking water supplies. These carcinogenic substances include chloroform and bromoform. MWQI studies have documented that Delta exports contain relatively high concentrations of DOC. Agricultural drainage discharges that contain natural organic matter from decomposing peat soil and crop residues are the major source of DOC in the Delta (California Department of Water Resources 1994b). Additionally, DOC is carried into the Delta from upstream inflows. Minimizing DOC concentrations in source waters is a major water quality goal for drinking water uses to meet new EPA regulations for DBPs. Utilities must undertake studies to control organic carbon in their source water if TOC exceeds 2 mg/l at the water intake.

Dissolved Oxygen. Dissolved oxygen (DO) concentrations serve as indicators of the balance between sources of oxygen (e.g., aeration and photosynthesis) and oxygen consumption (through decay and respiration processes). The capacity of water to dissolve oxygen decreases with increasing temperature and often varies with the cycle of daily photosynthetic activity of algae and plants. DO concentrations in Delta channels are not generally considered a problem, except in the waterways around Stockton and in some dead-end sloughs.

Nutrients. Nitrogen and phosphorous are the two nutrients which most often limit algal growth at low concentrations and trigger algal growth at elevated concentrations. Generally, in the presence of sufficient light and elevated temperatures, as nutrient concentrations increase algal productivity increases. A self perpetuating cycle of nutrient enrichment, plant growth, accumulation of muck, oxygen depletion, and nutrient recycling from the sediment follows. Eventually , the rate of oxygen consumption can exceed the rate of absorption, resulting in, blue-green algae blooms, odors, and eventually the death of fish and aquatic life. Drinking water taste and odor problems can occur from algae decomposition.

For agriculture excessive nutrients can result in excess vegetative growth, reduced yields, delayed or uneven maturity, or reduced quality. Algal growth stimulated by excess nutrients can increase facilities maintenance costs. In extreme cases, irrigation equipment for sprinkle and drip irrigation can plug, increasing maintenance costs. Sensitive crops may require an alternative or blended water supply, or may not be grown. Alternative, more tolerant crops can be grown, but other water quality parameters, land suitability and market conditions dictate crop selection.

Pathogens. Microbiological organisms of principal concern as agents of disease or indicators of potential contamination in drinking water include coliform bacteria, viruses and protozoan and helminth parasites. Total coliform bacteria measurements indicate the general level of urban and animal contamination of a water supply. Microbial agents have been responsible for waterborne outbreaks of infectious disease. Their presence in raw waters has been a principal thrust of water treatment technology. Waterborne diseases still occur in the United States. The Center for Disease Control (CDC) and EPA have estimated 1 million cases of illness per year and 1000 deaths per year due to waterborne diseases.

Principal waterborne bacterial agents that cause human intestinal disease are summarized in Table 3.2. Rather than attempt to analyze each of these pathogenic bacteria, water utilities routinely monitor for total and fecal coliform bacteria, an indicator organism. With few exceptions, these organisms, which originate in the intestinal tract of warm-blooded animals and other sources, are not pathogenic. Because coliforms are more abundant than pathogens in human waste by several orders of magnitude, the tests provide a margin of safety against pathogens. If coliforms are not detected, it is assumed that bacterial pathogens would not be likely to be present, or at least they are likely to be below the levels known to infect. Although the tests have limitations, they are still the most widely used indicators of bacterial water quality.

Viruses. In contrast to bacteria, enteric viruses are always assumed to be pathogenic. The prevailing theory is that only one infective unit (which may be as low as one virus) can cause infection. Because clinical symptoms do not always result from infections, because it is difficult to link infections to a waterborne source, because there are difficulties in detecting viruses, and because people are exposed to viruses from many sources, the extent of waterborne diseases due to viruses is not well quantified. The CDC estimates that of the 1 million of cases per year of illness from waterborne microorganisms, perhaps more than 50 percent are viral. Viruses of concern in drinking water are listed in Table 3.3. The enteroviruses (polio, Coxsackie A, Coxsackie B, and echoviruses), adenoviruses, reoviruses, the hepatitis viruses, and rotavirus can be detected by laboratory cell culture techniques.

Table 3.2 Principal Waterborne Bacterial Agents And Associated Health Effects

Bacteria	Disease
Salmonella typhi	Typhoid fever
Salmonella paratyphi-A	Paratyphoid fever
Salmonella (other species)	Salmonellosis, enteric fever
Shigella dysenteriae, S. flexneri, and *S. sonnei*	Bacillary dysentery
Vibrio cholerae	Cholera
Leptospira sp.	Leptospirosis
Yersinia enterocolitica	Gastroenteritis
Francisella tularensis	Tularemia
Escherischia coli (specific enteropathogenic strains)	Gastroenteritis
Pseudomonas aeroginosa	Various infections
Enterobacteriacae (Edwardsiella, Proteus, Serratia, Bacillus)	Gastroenteritis
Campylobacter	Gastroenteritis

Table 3.3 Enteric Viruses and Their Associated Diseases

Virus Group	Number of Types	Common Disease Syndromes
Enteroviruses		
Polioviruses	3	Poliomyelitis, aseptic meningitis
Coxsackieviruses A	23	Herpangina, asepticmeningitis, exanthem
Coxsackieviruses B	6	Aseptic meningitis, epidemic myalgia, myocarditis, pericarditis
Echoviruses	31	Aseptic meningitis, exanthem, gastroenteritis
Adenoviruses	31	Upper respiratory illness, pharyngitis, conjunctivitis
Reoviruses	3	Upper respiratory illness, diarrhea, exanthem
Hepatitis viruses		
Hepatitis A Virus	1	Viral hepatitis type A or infectious hepatitis
Hepatitis B Virus	4	Viral hepatitis type B or serum hepatitis
Rotavirus	2	Gastroenteritis
Norwalk agent	1	Gastroenteritis

Parasites. Eggs and cysts of parasitic protozoa and helminths (worms) excreted into the environment may enter water supplies. All can severely disrupt the intestinal tract. Two of these are *Giardia lamblia* and *Cryptosporidium parvum.* Their cysts/oocysts are far more resistant to disinfectants than bacteria or most viruses.

Giardia lamblia. *Giardia lamblia*, the intestinal protozoan most frequently found in human populations worldwide, is the most commonly identified agent of water-borne diseases in the United States (Feachem, et al., 1983). Waterborne giardiasis may be increasing in the U.S. with 95 outbreaks over the last 25 years. Over 60 percent of all *Giardia lamblia* infections are believed to be acquired from contaminated water. *Giardia lamblia* cysts are found in water contaminated by fecal material from infected humans and animals. *Giardia lamblia* forms an environmentally resistant cyst that allows the parasite to survive in surface water and treated drinking water.

Ingestion of as few as 10 cysts can cause infection (Rendtorff and Holt, 1954). Infection was measured by the excretion of cysts, and illness was not determined. The ratio of illness to infection is highly variable. *Giardia lamblia* infections with no symptoms of illness may be as high as 39 percent for children under 5 years old and 76 percent for adults in certain populations (Craft, 1981; and Wolf, 1979; as reported in Rose, et al., 1991). At the same time, symptomatic infections have been reported at a rate of 50 to 67 percent and as high as 91 percent in others (Veazie, et al., 1979, as reported in Rose, et al., 1991). In yet other groups, chronic giardiasis may develop in as many as 58 percent of an infected population.

Cryptosporidium parvum. *Cryptosporidium parvum*, an intestinal protozoan parasite, was first identified in 1907, but has been recognized to cause diarrheal disease in humans only since 1980. The first documented waterborne outbreak of cryptosporidiosis in humans occurred in the U.S. in 1985. In January 1988, EPA added *Cryptosporidium parvum* to the Drinking Water Priority List. The severe gastro-intestinal symptoms of the disease last an average of 12 days, and are self-limiting in people with normal immune function. Illness patterns vary with age, immune status, and variations in the virulence of *Cryptosporidium parvum.* Young mammals are more susceptible. For AIDS and cancer patients, cryptosporidiosis can cause mortality. The oocyst (infective stage) dose necessary to cause an infection in humans is unknown, but may be low; in a primate study, two individuals became infected after exposure to only 10 oocysts (Miller, et al. 1986). No effective treatment for the disease exists. *Cryptosporidium parvum* is transmitted between humans and warm-blooded animals, including cats, dogs, cattle, goats, mice, pigs, rats, and sheep (Fayer and Ungar, 1986, as reported in Rose, 1991). *Cryptosporidium parvum* from birds will not infect mammals, however. Common sources of *Cryptosporidium parvum* in water are wildlife in a watershed, sewage discharges, and domestic animals (including runoff from grazing lands and dairies). For example, surface water running through cattle pastures can contain up to 6,000 oocysts per liter (Madore, et al., as reported in Peeters, et al., 1989).

Cryptosporidium parvum in drinking water strongly resists chlorine disinfection. In addition, *Cryptosporidium parvum* levels do not correlate well with indicator coliform bacteria levels, so meeting standards for coliforms and turbidity (a measure of the reduction of clarity of a water by suspended particles) may not be a sufficient measure of treatment reliability for removal of *Cryptosporidium parvum*. Normal levels of chlorine in drinking water have been shown to be ineffective for inactivating *Cryptosporidium parvum*, even after 18 hours of contact. However, ozone and chlorine dioxide have been found to be more effective disinfectants (Peeters et al., 1989). Sand filtration alone reduces but does not completely eliminate oocyst concentrations. Filtration with coagulation achieves greater removals.

pH. The formation of DBPs in drinking water is dependent a variety of parameters, one of which is pH. pH of source water can affect the effectiveness of drinking water treatment technologies. For agriculture pH problems are related to potential corrosion or plugging of irrigation equipment (such as aluminum pipe and drip emitters) and precipitation of residues on plants (such as cut flowers in greenhouses). Nutritional imbalance can be caused by irrigation water with a pH outside of the normal range.

Sodium Absorption Ratio (SAR). SAR is of concern to agricultural beneficial uses. Sodium hazards in irrigation and soil waters can impair crop production. Unlike salinity, excessive sodium does not curtail the uptake of water by plants, but rather destroys soil structure and reduces the infiltration of water into the soil. Thus, plant growth can be affected by drought stress and lack of aeration. When calcium and magnesium are the predominant cations absorbed on soil particles, the soil tends to have a granular structure that is easily tilled and readily permeable. Unbalanced by other cations, large amounts of sodium can disperse soil particles, so that soil structure breaks down and hydraulic conductivity decreases. Good soil structure and adequate drainage are essential for sustainable soil and salinity management. Additional agronomic issues arising from excess sodium include soil crusting (especially over seedbeds), temporary saturation of the soil surface layer, and/or related disease, weed, root-respiratory, and nutritional problems. In extreme cases and for sensitive plants, sodium ions can be phytotoxic, much in the same manner as chloride. Management of sodium by leaching alone can be impractical because of problems with soil aeration and drainage. Sodium is generally managed by replacement with calcium through the addition of gypsum, or sulfuric acid, which reacts with soil calcium carbonate, to liberate calcium. These treatments must be followed by leaching with water of acceptable quality. In general, the benefit of a water-applied amendment is much greater when the irrigation water salinity is relatively low. The primary sources of sodium are seawater and agricultural drainage. SAR can affect crop yields and sensitive crops such as orchards and beans. It is a particular issue in the western and interior Delta.

Salinity. Salinity in of concern to municipal users because (1) bromide, a component of saline water, forms DBP precursors (bromide and total organic carbon); (2) there is a need for low salinity supplies to assure the feasibility of local wastewater reclamation and conjunctive use projects, (3) there is a need for low salinity supplies to minimize and retard the corrosion of infrastructure and appliances, (4) there is a need for low salinity supplies to improve the aesthetics of drinking water. Salinity is of concern to agricultural users because of potential plant toxicity problems. (California Urban Water Agencies (CUWA)/CALFED, 1996).

Sources of marine water include salt water intrusion into the Delta from San Francisco Bay and connate groundwater. The magnitude of saline water intrusion is influenced by Delta outflow, which defines the upstream boundary of the salinity wedge. Seawater is the primary source of salinity. Agricultural drainage from the Delta, upstream agricultural drainage from sources on the Sacramento and San Joaquin rivers, and urban runoff may also affect salinity concentrations. Urban runoff consists of dissolved minerals, whereas agricultural drainage is made up of soluble salts from irrigation water leached from the soils (CUWA, 1995).

Electrical Conductivity (EC), more correctly known as specific conductance, is the most common general measure of dissolved minerals in Delta waters. EC is generally considered a conservative parameter, not subject to sources or losses internal to a water body. Therefore, changes in EC values can be used to interpret the movement of water and the mixing of salts in the Delta. EC values increase with concentration, decrease with dilution, and may be elevated in agricultural drainage discharges and areas affected by seawater.

For agriculture, irrigation water quality affects the amount and type of salts found in soil. When water is applied as irrigation, crop uptake and evaporation remove pure water with some dissolved salts, particularly nutrient salts. However, most of the water's salt load remains in the crops root zone after uptake of water by roots. When water does not leach from the soil, but is only added to meet crop needs, the soil accumulates residual salt over time. If the frequency of leaching is too low, then salt concentrations may reach levels that stress growing plants. In general, salt influences plant growth by depriving the roots of water. Water uptake by plants is driven by differences in water content and salt concentration between the root interior and the soil. When the salt concentration of the soil increases, plants must accumulate salt themselves, or must dehydrate to continue to extract water from the soil.

Plants vary in their ability to adapt to saline conditions by these and other mechanisms; and therefore, vary in their ability to tolerate saline conditions. Even tolerant plants, though they survive, may not produce as much when grown under saline conditions. This is because extraction of water from saline soil requires more plant energy, which might otherwise be allocated for plant growth and metabolism. In addition to crop water uptake, salinity can affect agronomic system in other ways (See sodium). The major objective in selecting management practices to control salinity is to maintain adequate soil water availability to the crop. Procedures that require relatively minor changes in management are more frequent irrigation events, selection of more salt-tolerant crops, additional leaching, pre-plant irrigation events, and altered seed placement. Alternative that may require significant changes in management are changing the irrigation method, altering the water supply, land-grading, modifying the soil profile (deep ripping), and installing artificial drainage. Management practices must fit the method of irrigation. After salinization, one study showed 10 to 15 percent salt removal by leaching that should theoretically remove 50 percent of accumulated salinity (Mass & Hoffman, 1983). Field realities may influence saline land management.

Temperature. Temperature governs rates of biochemical processes and is a major environmental factor in determining organism preferences and behavior. Water temperatures in the Delta are generally a function of the weather and runoff conditions. Delta temperatures are influenced only slightly by water management activities. The most common environmental impacts associated with water temperatures are localized effects caused by discharges at substantially elevated temperatures (e.g., thermal shock). Fish growth, activity, and mortality are related to their temperature tolerances. The Delta supports fish species, such as the Chinook salmon and striped bass, that require different warm- and coldwater habitat conditions.

For agriculture temperature of irrigation water has direct and indirect effects on plant growth. Each occurs when physiological functions are impaired by excessively high or excessively low temperatures. The direct effects on plant growth from extreme temperature of the irrigation water occurs when the water is first applied, and they are less pronounced with pressure irrigation systems than with surface irrigation systems. Indirect effects of the temperature of irrigation water on plant growth occur as a result of the water's influence on soil temperature. Temperature effects are primarily related to rice seedling emergence and crop development. Rice production is concentrated in the northern San Joaquin and southern Sacramento valleys. When water is colder, irrigation facilities that spread water out for solar warming can be used, including shallow reservoirs and flooded fields. Some rice farms designate an upper part of the field for spreading and warming water, or else they accept lower productivity in parts of their farm that receive irrigation water directly from the canal.

Turbidity. Turbidity is a nonspecific measure of suspended matter such as clay, silt, organic particulates, plankton, and microorganisms. The presence of suspended solids (often measured as turbidity) is a general indicator of surface erosion and runoff into water bodies, resuspension of sediment materials, or biological productivity. Following major storms, water quality is often degraded by inorganic and organic solids and associated adsorbed contaminants (such as metals, nutrients, and agricultural chemicals) that are resuspended or introduced in runoff. Such runoff and resuspension episodes are relatively infrequent; persist for only a limited time; and, therefore, are not often detected in regular sampling programs. Large Delta inflows, sediment resuspension during dredging activities, agricultural drainage discharges, and suspended planktonic algae are the main causes of high SS concentrations.

The attenuation of light in Delta waters is controlled by SS concentrations (with some effects from chlorophyll). These concentrations are often elevated in the entrapment zone as a result of increased flocculation (i.e., aggregation of particles) in the estuarine salinity gradient. High winds and tidal currents also contribute to increased SS concentrations in the estuary. Suspended sediments tend to suppress algae growth in much of the Delta (California State Water Resources Control Board 1995a).

Turbidity is of concern in drinking water because it can render water aesthetically unacceptable to the consumer; reduce the efficiency of disinfection by shielding microorganisms; and act as a vehicle for the concentration, transport, and release of organic and inorganic toxicants, bacteria, and viruses.

From an agricultural perspective the effects of turbidity on plants and soils include the formation of crusts at the soil surface (inhibiting water infiltration and aeration, impeding seedling emergence, and hindering leaching of saline soils), and the formation of films on plant leaves (blocking sunlight and reducing photosynthesis and marketability). High colloidal content in water used for sprinkler irrigation can result in deposition of films on leafy vegetable crops such as lettuce, which affects marketability and management. Settleable matter in the water can prematurely decrease reservoir capacity, and increase maintenance requirements on delivery canals due to siltation. Turbidity also increases wear on pumping facilities. As agricultural lands in the Sacramento and San Joaquin valleys continue to be irrigated with low-volume irrigation systems like drip and micro-sprinkle, clogging, maintenance, and on-farm water management (filtration) requirements will need to be considered when selecting a new system or evaluating water supply. Filtration and maintenance requirements for turbid water for low-volume irrigation can be costly and may make the water unusable.

SOURCES OF INFORMATION

Water Quality Monitoring Programs

Federal, State and Local agencies conduct ongoing water quality monitoring programs in the Delta. The following section reviews previous and ongoing studies that provide primary data on key water quality parameters for CALFED.

Regional Programs

Interagency Ecological Program of the Sacramento-San Joaquin Estuary. The Interagency Ecological Program (IEP) was initiated by DWR, the California Department of Fish and Game (DFG), the U.S. Bureau of Reclamation (Reclamation), and the U.S. Fish and Wildlife Service (USFWS) to provide information about the effects of CVP and SWP exports on fish and wildlife in the Bay-Delta estuary. Analysis of water quality components focused on salinity and algal productivity (nutrient) effects. SWRCB, the U.S. Environmental Protection Agency (EPA), the U.S. Army Corps of Engineers (Corps), and the U.S. Geological Survey (USGS) currently provide additional program assistance. IEP investigations have changed periodically as new information is gathered and resource topics decrease or increase in importance. Program data are available to the public, annual IEP reports are issued, and newsletters and annual meetings provide information about study results.

San Francisco Estuary Regional Monitoring Program. The 1993, 1994, and 1995 Annual Reports for Trace Substances provide information on water quality monitoring data. Specifically, ambient concentration data is available throught the Delta and Bay regions for key parameters of concern.

Sacramento Coordinated Water Quality Monitoring Program. The Sacramento River Coordinated Monitoring Program was initiated in 1991 by the City and County of Sacramento. The program is now a component of the larger Sacramento River Watershed Program. Sampling under the program began in December, 1992. Ambient water quality monitoring is conducted at five locations on the lower Sacramento River in the vicinity of Sacramento. Water quality data is reported in annual reports for 1992 to 1995.

Federal Programs

Environmental Protection Agency

Clean Water Act Section 305(b). SWRCB is required to report (biennially) on water quality conditions in California streams, lakes, and groundwater basins. Individual Delta channels are not classified in the Section 305(b) reports.

*Clean Water Act Section 303(d).*Requires states to identify water bodies within their boundaries that exceed water quality standards. As a result, the California State Water Resources Control Board identifies and maintains a list of the State's impaired waterbodies. For each water body, the SWRCB identifies the water quality problem, its source(s), and areal extent. In addition to indentifying imparied water bodies, states are required to prioritize the impaired water bodies based on the severity of the water quality problem and their use and to estimate the maximum parameter load allowable, known as the total maximum daily load (TMDL). In 1996, the SWRCB identified approximately 95 impaired water bodies within California. Currently, the 303(d) list of impaired water bodies is reviewed and reported biennially to coincide with the 305(b) reporting schedule.

United States Geological Survey

Much of the available water temperature information came from USGS records, which were obtained from the compact-disk version of U.S. Geological Survey (USGS) WATSTORE database. Additonal USGS data on water quality and streamflow was found using the National Water Quality Monitoring Networks (WQN) HomePage.

State Programs

California Department of Water Resources

Municipal Water Quality Investigations Program. DWR's Municipal Water Quality Investigations (MWQI) Program encompasses the previous Interagency Delta Health Aspects Monitoring Program (IDHAMP) and Delta Island Drainage Investigations (DIDI). IDHAMP was initiated to provide water quality information for judging the suitability of the Delta as a source of drinking water (California Department of Water Resources 1989). Issues of concern included sodium, asbestos, and the potential formation of DBPs. More water quality constituents have been added, including the characterization of Delta inflows and exports, to provide a means of chemically tracking the movement of water through the Delta. The DIDI program started collecting agricultural drainage samples containing pesticide residues, organic materials, and THM precursors in 1985 to evaluate drainage quality among islands with different soil and farming practices (California Department of Water Resources 1990).

DAYFLOW Records. Daily Delta hydrology is specified in the DAYFLOW data base maintained by DWR Central District. The DAYFLOW records, include daily CVP Delta operations for 1967-1991. Simulation results from the monthly Delta operations planning models are known as DWRSIM.

State Water Resources Control Board

Delta Flow and Salinity Measurements. SWRCB requires DWR and Reclamation to conduct comprehensive water quality monitoring of the Delta and adjust SWP and CVP operations to satisfy the applicable objectives. Salinity (EC) monitoring stations at Jersey Point and Emmaton are especially important for managing releases at upstream reservoir and export pumping to satisfy water quality objectives. DWR's Delta Operations Water Quality Section prepares and distributes a daily report of data on flows and EC to help in making operational decisions. Reclamation also maintains continuous EC recorders at approximately 20 Delta locations.

Sediment Monitoring Programs

State Programs

Department of Water Resources

Interim North Delta Water Management Program. In an effort to define the potential environmental impact that would result from proposed dredging that could occur in the North Delta area, a field investigation was conducted in the fall and winter of 1992 to collect and analyze sediment samples for chemicals of environmental concern.

Interim South Delta Water Management Program. This environmental study was conducted to help determine the impact that could result from proposed dredging activities associated with the ISDP, including the effects of the physical and chemical components of the dredged material on the environment. The ISDP area generally comprises lands and channels southwest of Stockton and north of Tracy.

Dredging Projects (Staten Island, South Fork Mokelumne River, North Delta). From 1990 to 1994 sediment samples were collected during actural dredging operations.

Biological Tissue Monitoring Programs

State Programs

State Water Resources Control Board
Mussel Watch Program.

Toxic Substances Monitoring Program. Initiated in 1976, the Toxic Substances Monitoring Program (TSMP) was based on sampling aquatic organisms (e.g., freshwater clams, carp, bass, and trout) in major California water bodies to determine the extent of accumulation of synthetic organic chemicals and heavy metals in tissue (California State Water Resources Control Board 1985). Funding for the TSMP was discontinued in 1996.

Additional Sources of Information

Ongoing studies and analyses of the Delta region serve as important sources of information for the CALFED Water Quality Program. Recent studies and reports include the California Department of Water Resources (DWR) Bulletin 160-93, California Water Plan Update (California Department of Water Resources 1994); documentation for the U.S. Bureau of Reclamation's (Reclamation's) CVP operations (U.S. Bureau of Reclamation 1992); an environmental report prepared by the State Water Resources Control Board (SWRCB) in support of the 1995 Delta water quality control plan (State Water Resources Control Board 1995); estuarine standards proposed in December 1993 by the Environmental Protection Agency (EPA); draft environmental documents for major water resource projects in or adjacent to the Delta, including the Contra Costa Water District's (CCWD's) Los Vaqueros Project (Contra Costa Water District and U.S. Bureau of Reclamation 1993); DWR's North-Delta program (California Department of Water Resources 1990a), and South-Delta program (California Department of Water Resources 1990b); Interim South-Delta Program (California Department of Water Resources 1996a); Los Banos Grandes (California Department of Water Resources 1990c); and the Draft EIR/EIS for the Delta Wetlands Project (Jones & Stokes Associates 1995).

Additional sources of information for the water quality parameters of concern can be found in Appendix B. For this report data availability is summarized for informational purposes only. Data evaluation will be used more extensively as part of the EIR/EIS impact assessment process.

Target Ranges for Parameters

A frame of reference is required in order to understand the relevance of data regarding parameters of concern. For some parameters, particularly those affecting environmental beneficial uses, source water quality regulatory standards, objectives or criteria have been developed. In other cases, such as at municipal and agricultural water intakes, source water quality standards have not been developed. The Water Quality Technical group reviewed the existing regulatory requirements and the specific requirements of each beneficial use. Based on this review they recommended target ranges for each parameter of concern at critical locations throughout the CALFED water quality solution area. Table 3.4 summarizes the source water quality targets for each parameter of concern.

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Table 3.4 CALFED Water Quality Parameters of Concern Target Ranges

	Target Ranges		
Parameter	**Sacramento River**	**San Joaquin River**	**Delta**
Boron			Water: Agricultural Intakes: **< 0.7 mg/l**
Cadmium	Water: River and Tributaries from above State Hwy 32 bridge at Hamilton City: **0.22 µg/l** [a,c,d] Below Hamilton City: **2.2 µg/l** (4 day average) [a,e] **4.3 µg/l** (1 hour average) [a,e] Sediment: [z] **5.0 ppm** (dry weight)	Water: **2.2 µg/l** (4 day average) [a,e] **4.3 µg/l** (1 hour average) [a,e] Sediment: [z] **5.0 ppm** (dry weight)	Water: East of Antioch Bridge: **2.2 µg/l** (4 day average) [a,e] **4.3 mg/l** (1 hour average) [a,e] West of Antioch Bridge: **1.1 µg/l** (4 day average) [x] **3.9 µg/l** (1 hour average) [x] Sediment: [z] **1.2 ppm** (dry weight)
Copper	Water: River and Tributaries from above State Hwy 32 bridge at Hamilton City: **5.6 µg/l** [a,c,d] Below Hamilton City: **10 µg/l** (no hardness connection) [a,d,f] Sediment: [z] **70.0 ppm** (dry weight)	Water: **9.0 µg/l** (4 day average) [a,e] **13 µg/l** (1 hour average) [a,e] Sediment: [z] **70.0 ppm** (dry weight)	Water: East of Antioch Bridge: **10 µg/l** (no hardness connection) [a,d,f] West of Antioch Bridge: **6.5 µg/l** (4 day average) [x] **9.2 µg/l** (1 hour average) [x] Sediment: [z] **34.0 ppm** (dry weight)

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Table 3.4 CALFED Water Quality Parameters of Concern Target Ranges

	Target Ranges		
Parameter	**Sacramento River**	**San Joaquin River**	**Delta**
Mercury (inorganic)	Water: **0.012 µg/l** (4 day average) [b,e] **2.1 µg/l** (1 hour maximum) [a,e] Sediment: [z] **0.15 ppm** (dry weight) Tissue: [i,y] **0.5 µg/gm** (whole fish, wet weight)	Water: **0.012 µg/l** (4 day average) [b,e] **2.1 µg/l** (1 hour maximum) [a,e] Sediment: [z] **0.15 ppm** (dry weight) Tissue: [i,y] **0.5 µg/gm** (whole fish, wet weight)	Water: East of Antioch Bridge: **0.012 µg/l** (4 day average) [b,e] **2.1 µg/l** (1 hour maximum) [a,e] West of Antioch Bridge: **0.025 µg/l** (4 day average) [x] **2.4 µg/l** (1 hour average) [x] Sediment: [z] **0.15 ppm** (dry weight) Tissue: [i,y] **0.5 µg/gm** (whole fish, wet weight)
Selenium	Water: **20 µg/l** (1 hour maximum) [b,e] **5.0 µg/l** (4 day average) [b,e] Tissue: [aa] **4-12 ppm** (fish, whole body, dry weight) **3-7 ppm** (fish food items, food chain, dry weight)	Water: [j] South of Merced River: **20 µg/l** (1 hour maximum) [b,e] **5.0 µg/l** (4 day average) [b,e] North of Merced River: **12_mg/l** (maximum) [b,e] **5.0 µg/l** (4 day average) [b,e] Tissue: [aa] **4-12 ppm** (fish, whole body, dry weight) **3-7 ppm** (fish food items, food chain, dry weight)	Water: East of Antioch Bridge: **20 µg/l** (1 hour maximum) [b,e] **5.0 µg/l** (4 day average) [b,e] West of Antioch Bridge: **20 µg/l** (1 hour average) [b,e] **5.0 µg/l** (4 day average) [b,e] Tissue: [aa] **4-12 ppm** (fish, whole body, dry weight) **3-7 ppm** (fish food items, food chain, dry weight)

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Table 3.4 CALFED Water Quality Parameters of Concern Target Ranges

Parameter	Target Ranges: Sacramento River	Target Ranges: San Joaquin River	Target Ranges: Delta
Zinc	Water: River and Tributaries from above State Hwy 32 bridge at Hamilton City: **16 µg/l** [a,c,d] Below Hamilton City: **100 µg/l** (no hardness connection) [a,d,g] Sediment: [z] **120.0 ppm** (dry weight)	Water: **120 µg/l** (4 day average) [a,e] **120 µg/l** (1 hour average) [a,e] Sediment: [z] **120.0 ppm** (dry weight)	Water: East of Antioch Bridge: **100 µg/l** (no hardness connection) [a,d] West of Antioch Bridge: **106µg/l** (4 day average) [x] **117 µg/l** (1 hour average) [x] Sediment: [z] **150.0 ppm** (dry weight)
Carbofuran	Water:[k] **0.4 µg/l** (daily max. and total pesticide) [h]	Water: **0.4 µg/l** (daily max. and total pesticide) [h]	Water: **0.4 µg/l** (daily max. and total pesticide) [h]
Chlordane	Water: **2.4 µg/l** (instantaneous max.) [e] **0.0043 µg/l** (4 day average, total pesticide) [e] Sediment: [z] **7.1 ppm** (dry weight)	Water: **2.4 µg/l** (instantaneous max.) [e] **0.0043 µg/l** (4 day average, total pesticide) [e] Sediment: [z] **7.1 ppm** (dry weight)	Water: **2.4 µg/l** (instantaneous max.) [e] **0.0043 µg/l** (4 day average, total pesticide) [e] Sediment: [z] **7.1 ppm** (dry weight)
Chlorpyrifos	Water:[m] **0.02 µg/l** (4 day average, total pesticide) [l,g]	Water:[m] **0.02 µg/l** (4 day average,total pesticide) [l,g]	Water:[m] **0.02 µg/l** (4 day average,total pesticide) [l,g]
Diazinon	Water:[n] **0.08 µg/l** (1 hour average,total pesticide)[l] **0.04 µg/l** (4 day average, total pesticide)[l]	Water:[n] **0.08 µg/l** (1 hour average,total pesticide)[l] **0.04 µg/l** (4 day average, total pesticide)[l]	Water:[n] **0.08 µg/l** (1 hour average,total pesticide)[l] **0.04 µg/l** (4 day average, total pesticide)[l]

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Table 3.4 CALFED Water Quality Parameters of Concern Target Ranges

	Target Ranges		
Parameter	**Sacramento River**	**San Joaquin River**	**Delta**
DDT	Water: **1.1 µg/l** (instantaneous max., total pesticide) [e] **0.001 µg/l** (4 day average, ,total pesticide) [e] Tissue: [y] **1 µg/l** (whole fish, wet weight)	Water: **1.1 µg/l** (instantaneous max., total pesticide) [e] **0.001 µg/l** (4 day average, ,total pesticide) [e] Tissue: [o,y] **1 µg/l** (whole fish, wet weight)	Water: East of Antioch Bridge: **1.1 µg/l** (instantaneous max., total pesticide) [e] **0.001 µg/l** (4 day average, ,total pesticide) [e] West of Antioch Bridge: **1.1 µg/l** (instantaneous maximum) **0.001 µg/l** (24 hour average) Tissue: [y] **1 µg/l** (whole fish, wet weight)
PCB's	Water: **0.014 µg/l** (4 day average) [e] (each of 7 congeners) Sediment: [z] **50 ppm** (dry weight, total) Tissue: [y] **0.5 µg/l** (whole fish, wet weight, total)	Water: **0.014 µg/l** (4 day average) [e] (each of 7 congeners) Sediment: [z] **50 ppm** (dry weight, total) Tissue: [y] **0.5 µg/l** (whole fish, wet weight, total)	Water: East of Antioch Bridge: **0.014 µg/l** (4 day average) [e] (each of 7 congeners) West of Antioch Bridge: **0.014 µg/l** (24 hour average) Sediment: [z] **50 ppm** (dry weight, total) Tissue: [y] **0.5 µg/l** (whole fish, wet weight, total)

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Table 3.4 CALFED Water Quality Parameters of Concern Target Ranges

	Target Ranges		
Parameter	**Sacramento River**	**San Joaquin River**	**Delta**
Toxaphene	Water: **0.73 µg/l** (1 hour average) [e] **0.0002 µg/l** (4 day average) [e] Tissue: [y] **0.1 µg/l** (whole fish, wet weight) (sum of 9 organochlorine insecticides)	Water: **0.73 µg/l** (1 hour average) [e] **0.0002 µg/l** (4 day average) [e] Tissue: [y] **0.1 µg/l** (whole fish, wet weight) (sum of 9 organochlorine insecticides)	Water: East of Antioch Bridge: **0.73 µg/l** (1 hour average) [e] **0.0002 µg/l** (4 day average) [e] West of Antioch Bridge: **0.0002 µg/l** (4 day average) [e] Tissue: [y] **0.1 µg/l** (whole fish, wet weight) (sum of 9 organochlorine insecticides)
pH (Alkalinity as $CaCO_3$)			Water: Agricultural Intakes: **< 1.5 me/l**
Ammonia	Water: **0.08 - 2.5 µg/l** (4 day average) [e,p] **0.58 - 35 µg/l** (1 hour average) [e,p]	Water: **0.08 - 2.5 µg/l** (4 day average) [e,p] **0.58 - 35 µg/l** (1 hour average) [e,p]	Water: East of Antioch Bridge: **0.08 - 2.5 µg/l** (4 day average) [e,p] **0.58 - 35 µg/l** (1 hour average) [e,p] West of Antioch Bridge: **0.025 µg/l** (annual median) **0.16 µg/l** (maximum)
Bromide			Water: Drinking Water Intakes: **50 µg/l** [gg, hh]
TOC			Water: Drinking Water Intakes: **3 mg/l** [gg]

Table 3.4 CALFED Water Quality Parameters of Concern Target Ranges

	Target Ranges		
Parameter	**Sacramento River**	**San Joaquin River**	**Delta**
Chloride			Water: Agricultural Intakes: For surface irrigation: [bb] **SAR: < 3** [cc] For sprinkle irrigation: [dd] **< 3 me/l** Drinking Water Intakes: **250 mg/l** [ii]
Nutrients (Nitrate)			Water: Agricultural Intakes: **< 5.0 mg/l** Drinking Water Intakes: **10 mg/l** [jj]
Salinity (EC_w)			Water: East of Antioch Bridge: West of Antioch Bridge: Agricultural Intakes: **< 0.7 dS/m or mmho/cm** [ee]
SAR:EC_w [ff] relationship			Water: Agricultural Intakes: SAR EC_w: **0 - 3 > 0.7** **3 - 6 > 1.2** **6 - 12 > 1.9** **12 - 20 > 2.9** **20 - 40 > 5.0**

Table 3.4 CALFED Water Quality Parameters of Concern Target Ranges

	Target Ranges		
Parameter	**Sacramento River**	**San Joaquin River**	**Delta**
Salinity (TDS)	Water:	Water:	Water: East of Antioch Bridge: West of Antioch Bridge: Agricultural Intakes: **< 450 mg/l** Drinking Water Intakes: **500 mg/l** [ii]
Dissolved Oxygen	Water: Keswick Dam to Hamilton City, June 1 to August 31: **9000 μg/l** [d,q] Below I Street Bridge: **7000 μg/l** [d]	Water: Between Turner Cut and Stockton, September 1 through November 30: **6000 μg/l** [d]	Water: [s] All Delta waters west of Antioch Bridge: **7000 μg/l** (minimum) [d,x] All Delta waters: **5000 μg/l** [d,r]
Pathogens			Water: Drinking Water Intakes: **no MCL standard** [kk]
Temperature	Water: Keswick Dam to Hamilton City: **< 56° F** [d,u] Hamilton City to I Street Bridge: **< 68°F** [d,u] I Street Bridge to Freeport: **< 68°F** [d,v] I Street Bridge to Freeport, January 1 through March 31:**< 66°F** [d,w]	Water: At Vernalis: **< 68°F** [d,v]	Water: West of Antioch Bridge: < **5°C** increase above for receiving water designated as cold or warm freshwater habitat. [x] Alteration of temperature shall not adversely affect beneficial uses. [x] Agricultural Intakes:

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Table 3.4 CALFED Water Quality Parameters of Concern Target Ranges

	Target Ranges		
Parameter	**Sacramento River**	**San Joaquin River**	**Delta**
Turbidity			Water: West of Antioch Bridge: **No adverse effect or > 10 % change** Drinking Water Intakes: **0.5 or 1.0 NTU** [ii] Agricultural Intakes:
Unknown Toxicity [t]			Water: West of Antioch Bridge: Acute- A median of not less than **90%** survival and a 90 percentile of not less than **70%** survival Chronic - **no chronic toxicity** in ambient waters

[a] dissolved form
[b] total recoverable form
[c] The effects of these concentrations were measured by exposing test organisms to dissolved aqueous solutions of 40 mg/l hardness that had been filtered through a 0.45 micron membrane filter. Where deviations from 40 mg/l of water hardness occur, the objectives, in mg/l shall be determined using the following formulas:

$Cu = e^{(0.905)(\ln hardness)} - 1.612 \ X\ 10^3$

$Zn = e^{(0.830)(\ln hardness)} - 0.289\ X\ 10^3$

$Cd = e^{(1.160)(\ln hardness)} - 5.777\ X\ 10^3$

[d] Central Valley Regional Water Quality Control Plan
[e] General EPA 304(a) guideline
[f] Within the next year the State Water Resources Control Board or EPA will promulgate/adopt objectives which are hardness dependent. The adoption language is likely to contain a clause saying that the most stringent objective applies. Sometimes the 10 µg/l objective will be more stringent and at other times the new rule will be more stringent.
[g] Similar to the objectives for copper, we expect the State Water Resources Control Board or EPA to promulgate new objectives within the next year which will be more stringent than current objectives.
[h] The Central Valley Regional Water Quality Control Board expects to adopt an objective for carbofuran within the next year. The objective will probably be very similar to the performance goal.
[i] Water quality limited segments for mercury in fish tissue occur in the Sacramento River and Delta.
[j] Water quality limited segments for selenium in the water column from Salt Slough to Vernalis on the San Joaquin River.

[k] Lower Sacramento River is a water quality limited segment for carbofuran.

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Table 3.4 CALFED Water Quality Parameters of Concern Target Ranges

[l] California Department of Fish and Game acute (1 hour) and chronic (4 day) hazard assessment criteria.
[m] Sacramento River, San Joaquin River, and Delta water quality limited segments for chlorpyrifos.
[n] Sacramento River, San Joaquin River, and Delta water quality limited segments for diazinon.
[o] San Joaquin River water quality limited segment for DDT in tissue.
[p] Values are a function of pH, temperature, and designation of water body as cold or warm water beneficial use.
[q] When natural conditions lower dissolved oxygen below this level, the concentrations shall be maintained at or above 95% of saturation.
[r] Except those water bodies which are constructed for special purposes and from which fish have been excluded or where the fishery is not important and a beneficial use.
[s] Southern Delta around Stockton is a water quality limited segment for dissolved oxygen.
[t] Bioassay results or other special studies demonstrate toxicity. Sacramento River, San Joaquin River, and Delta are water quality limited segments for "unknown toxicity".
[u] The temperature shall not be elevated above 56^{B}F in the reach form Keswick Dam to Hamilton City nor above 68^{B}F in the reach from Hamilton City to I Street Bridge during periods when temperature increases will be detrimental to the fishery.
[v] The daily average water temperature shall not be elevated by controllable factors above 68^{B}F from the I Street Bridge to Freeport on the Sacramento River, and at Vernalis on the San Joaquin River between April 1 through June 30 and September 1 through November 30 in all water year types.
[w] The daily average water temperature shall not be elevated by controllable factors above 66^{B}F from the I Street Bridge to Freeport on the Sacramento River between January 1 through March 31.
x San Francisco Regional Water Quality Control Board objectives at 100 mg/l hardness. Formulas for calculating objectives for varying hardness levels are as follows:

$Cd = e^{(0.7852H - 3.490)}$ (4 day average)
$= e^{(1.128H - 3.828)}$ (1 hour average)
$Cu = e^{(0.8545H - 1.465)}$ (4 day average)
$e^{(0.9422H - 1.464)}$ (1 hour average)
$Zn = e^{(0.8473H + 0.7614)}$ (4 day average)
$= e^{(0.8473H + 0.8604)}$ (1 hour average)

[y] National Academy of Sciences (NAS)-National Academy of Engineering 1973
[z] Effect range-low (ERLs) concentrations
[aa] San Luis Drain Reuse, Technical Advisory Committee Selenium ecological risk guidelines
[bb] For surface irrigation, most tree crops and woody plants are sensitive to sodium and chloride, use the values shown. Most annual crops are not sensitive, use the salinity tolerance in Ayers and Westcot or equivalent.
[cc] SAR means sodium adsorption ratio. SAR is sometimes reported by the symbol RNa.
[dd] For overhead sprinkle irrigation, and low humidity (< 30%), sodium and chloride greater than 70 or 100 mg/l, respectively, have resulted in excessive leaf adsorption and crop damage to sensitive crops, see Ayers and Westcot.
[ee] EC_w means electrical conductivity of irrigation water, reported in mmho/cm or dS/m.
[ff] At a given SAR, the infiltration rate increases as salinity EC_w increases. To evaluate a potential permeability problem examine SAR and EC_w together.
[gg] Value arrived at in discussion with California Urban Water Agencies (CUWA)
[hh] Bromide value is predicated on the assumption that the MCL for Bromate will be 5 µg/l.

[ii] U.S. EPA Secondary MCL. 1995.
[jj] U.S. EPA Current MCL. 1995.
[kk] U.S. EPA requires removal of 99.9 % of Giardia and 99.99% of viruses during water treatment.

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SECTION 4

SOURCES AND LOADINGS OF PARAMETERS

Identifying the sources of a parameter is critical to developing action strategies to mitigate for problems caused by the parameter. Finding the source however, is only the first step in the process. Targeted action strategies must depend on understanding the relative importance of the source to the overall problem. Relative importance can only be understood if the forms of the parameter that impact benefical uses have been identified and the loadings of the critical forms, attributable to identified sources, have been calculated.

Sources of Parameters

Sources of water quality parameters of concern in the Delta and its tributaries include:

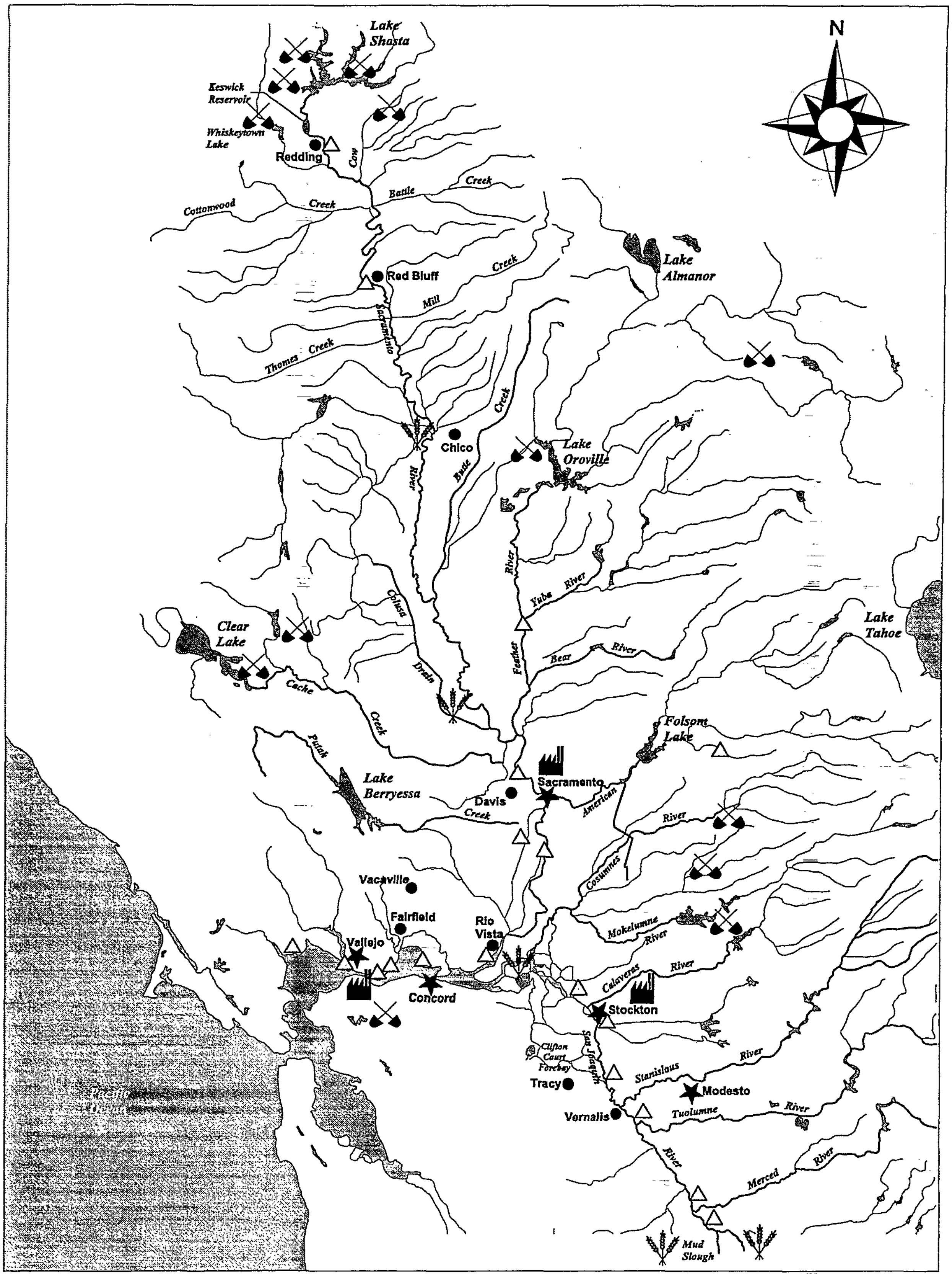
- acidic drainage from inactive and abandoned mines that introduce metals such as cadmium, copper, zinc, and mercury;
- stormwater inflows and urban runoff that may contribute metals, selenium, turbidity, pathogens, organic carbon, nutrients, pesticides, petroleum and other chemical residues;
- municipal and industrial discharges that may contribute salts, metals, trace elements, nutrients, pathogens, chemical residues, oil and grease, and turbidity;
- agricultural tail water, or return flows, that may contribute salts, nutrients, pesticide residues, pathogens, and turbidity; and,
- subsurface agricultural drainage that may contribute salts, selenium and other trace elements, nutrients, and pesticides (some fungicides).

Potentail sources of the parameters of concerns are shown in Figure 4-1.

The majority of mine drainage problems are either directly or indirectly associated with the mining of gold or base metals. The Central Valley Regional Water Quality Control Board (CVRWQCB) presently manages 94 inactive mines under Waste Discharge Requirement (WDR) and NPDES permitting programs. Sampling during the period of 1987 through 1992 indicates that 80 percent of cadmium, 72 percent of zinc and 73 percent of copper in the Sacramento River comes from past mining activities.

The greatest concentration of mines can be found around Shasta Lake, with Iron Mountain Mine complex being considered the largest source in the Central Valley. Other mines can be found in the western slope foothills of the Sierra Nevada Mountains. The most notable mines are the Penn, Walker, Cherokee and Newton Mines.

Iron Mountain Mine, located nine miles northwest of Redding, is one of the largest, most acidic



LEGEND

WASTEWATER TREATMENT PLANT

CITIES UNDER 100K POPULATION

CITIES OVER 100K POPULATION

AGRUCULTURAL DRAINS

INDUSTRIAL FACILITIES

MINE - INACTIVE OR ABANDONED

FIGURE 4-1 - POTENTIAL SOURCES OF PARAMETERS OF CONCERN

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draining mines in the world. Numerous mining opeating including open pit mining and tunnel mining have been conducted at Iron Mountain since the early 1860's for iron, silver, copper, gold and pyrite. Mining operations were discontinued. Today rainwater percolates through the open pit through exposed sulfide ores forming sulfuric acid. This acidic water solubilizes available cadmium, copper and zinc. Drainage from mine "portals" can reach temperature of 100 degrees Fahrenheit and have the acidity of a car battery. Runoff from the portal, tailing piles, and exposed soil collects in Spring Creek which drains into the Sacramento River via Keswick Reservoir below Shasta Dam. During peak flows Spring Creek may carry as much as twelve tons of metal per day.

The Sacramento River accomodates the largest number of spawning salmon in the State. All four chinook salmon runs (winter, spring, fall and late-fall) . Fall-run is the most abundant. Winter-run is listed as endangered. Unlike other salmon, the winter-run does not spawn immediately after making the long journey up the Sacramento River. The adult fish hold over for several months before they spawn. The twenty mile reach of the Sacremnto River below Keswick Dam currently provides most of the remaining natural spawning habitat for these salmon. Fall-run salmon fry are especially vulnerable during uncontrolled winter spills from Spring Creek Dam because of their maximum abundance during their most sensitive life stage immediately below Keswick Reservoir.

Mercury has been used historically to refine gold from gold bearing ore. The mercury binds with the gold to form an amalgam. The compound is then heated in the presence of nitric acid to separate the mercury from the gold. Much of the waste mercury was lost or mishandled during the refining process. The majority of the California mercury mines were located on the western side of the Central Valley and the majority of the gold mines were located on the eastern side of the Central Valley. This required the mining and transport of large volumes of mercury across the valley. It is estimated that 70 million tons of mercury were transported this way during the Gold Rush Era. The CVRWQCB currently monitors six inactive mercury mines. The most notable are the Corona, Manzanita, New Idria and Mt. Diablo Mines. Effects of past mercury mining and gold refining operations are being studied on Cache Creek and the Consumnes River.

Recently passed Senate Bill 1108 has alleviated some liability issues making it more feasible for the State to undertake mine remediation projects.

Loadings of Parameters

Where information was available estimated loadings for parameters of concern were developed. These estimates are shown in Tables 4.1 to 4.10 . Source loadings of parameters are primarily due to either agricultural or mine drainage, wastewater/industrial discharges, urban/industrial runoff or flow regulation. These tables illustrate the relative loadings of parameters from four of the five CALFED study regions (e.g., Bay, Delta, San Joaquin, and Sacramento). Additional information that was used in compiling these tables can be found in Appendix C.

Estimated Loadings of Parameter of Concern

Load estimates were made for four regions, the Sacramento River Basin, the San Joaquin River Basin, the Delta, and the Bay Region. The Sacramento River Basin estimates were further subdivided into loads generated above and below the three major dams, Shasta, Oroville and Nimbus.

Load estimates will be used to determine the relative importance of different parameter of concern sources and the potential effectiveness of CALFED water quality actions. For example, it may be determined that municipal and industrial wastewater treatment plants contribute less than 5% of the copper discharges to the Delta. It is apparent from the copper loading estimate that additional *measures to reduce copper from this source are unlikely to greatly affect copper concentrations in* the Delta.

Analytical Approach and Organization of Information

Considerable information on pollutants discharged to the Sacramento River Basin, the San Joaquin River Basin, the Delta, and the Bay Region and pollutant concentrations in various water bodies is available but it is not found in a single depository. Developing a comprehensive picture of pollutant loadings involves compilation of potentially-relevant data from published and unpublished sources, review of the data by the CALFED water quality team and, in many cases, further manipulation of the data into the form of load estimates.

Pollutant load estimates are difficult to make for large geographical areas because data is always limited and many assumptions have to be made. The approach used here was to try to make fairly complete load estimates for the various parameters even if fairly gross assumptions have to be made. The load estimates will then be progressively refined as additional data is acquired and analyses completed.

The following analytical report includes a number of separate sections addressing each key parameter. Each section consists of a tabular and graphical summary of loading data and a series of notes. The notes (see Appendix C) describe the data sources and any analyses undertaken to produce the load estimates.

Two approaches to load estimation were used and their results compared in the tabular and graphical summaries. The first approach was to estimate the load attributable to each major source and then to sum the loads up to provide a total basin load. Major contaminant source categories include agricultural stormwater runoff and subsurface drainage, mine drainage, municipal and industrial wastewater discharges and urban stormwater runoff. The second approach was to estimate the total pollutant emission from a basin by calculating the load contained in water exiting the basin at its downstream end. The loads calculated using the two approaches are not directly comparable because some of the pollutants discharged to waterways in a basin may be stored in sediments and biota or transformed into other substances, as a consequence of chemical reactions and biological activity.

Limitations

Because of the many assumptions and simplifications involved in the load estimates the results need to be used with caution. The more important assumptions and simplifications are noted below.

Year-to-year variations

Most contaminant sources are affected by meteorological conditions. The total contaminant loads from agricultural and urban runoff depend on the volume of runoff which can vary widely from year-to-year. Mine drainage loads are similarly weather-dependent. Waste loads associated with municipal and industrial wastewater discharges are less affected by weather; the same may be true for waste loads in agricultural subsurface drainage which probably depend more on irrigation rates than precipitation.

Because the data available to characterize contaminant loads is limited it was not separately compiled for different meteorological conditions. Ideally, loads should be separately estimated for wet, normal, dry and very dry years. Instead data from different years, representing different meteorological conditions were compiled to produce a single load estimate that may approximate "typical" conditions.

Seasonality of loadings

Most contaminant emissions vary seasonally. The initial load estimates contained in this report were made on an annual basis. If the available data allows, later refinement of the load estimates will seek to account for seasonality.

Background loads

The load estimates do not attempt to account for background loads. Many substances regarded as contaminants occur at low concentrations in waters uninfluenced by human activities. This is the case for metals and trace elements, salts, naturally-occurring organic substances and plant nutrients. It is not so for synthetic organic including pesticides.

The lack of allowance for background loads probably does not greatly affect load estimates for relatively concentrated waste streams. If, for example, a city draws water from a river, uses it for municipal supply and discharges it back to the river after wastewater treatment then the phosphorus load attributable to the municipal wastewater discharge is the load contained in the effluent less the background load contained in the source water. In this case, the background phosphorus concentration might be 0.05 mg/l while the concentration of phosphorus in the wastewater effluent would be 5 or 10 mg/l. The phosphorus load would be similar whether or not the background concentration is allowed for.

Lack of an adjustment for background loads can have a greater effect on loads attributable to dilute, but high-volume, waste streams. For example, copper concentrations in agricultural runoff may be estimated to be 0.01 mg/l while copper concentrations in runoff from non-agricultural lands with similar soil chemistry characteristics may be 0.005 mg/l. Not accounting for the background concentration in the load calculations would result in an overestimation of loads attributable to agricultural runoff by a factor of 2.

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Table 4.1 Bromide Loadings

BROMIDE LOADING TABLE										
	Bromide Loading (pounds/year)									
Source	Delta	Note	Lower Sacramento Basin below dams	Note	San Joaquin Basin	Note	Bay Region	Note	Upper Sacramento Basin above Dams	Note
Agricultural										
Mine Drainage										
M&I Wastewater (POTW)										
Urban Runoff										
Flow Regulation										
Total Load										
Basin Emission			172	*a*	535	*b*				

Note: Letters listed in italics under the Note column provide the background and references associated with the accompanying load

Data available; flow and concentration data available; load calculations required.

Further literature review required.

- Source does not contribute significant load of constituent in this watershed.

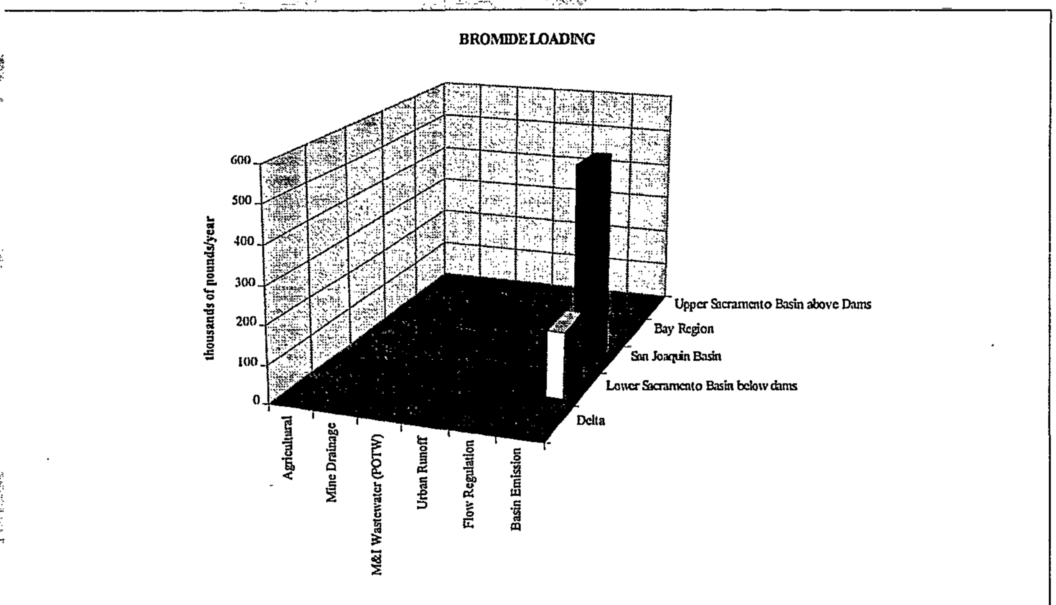

Table 4.2 Cadmium Loading

CADMIUM LOADING TABLE										
	Cadmium Loading (pounds/year)									
Source	Delta	Note	Lower Sacramento Basin below dams	Note	San Joaquin Basin	Note	Bay Region	Note	Upper Sacramento Basin above Dams	Note
Agricultural			655	*d*						
Mine Drainage	36	*a*	96,000	*e*	36	*i*				
M&I Wastewater (POTW)	154	*b*	270	*f*	202	*j*	6394	*m*		
Urban Runoff	136	*c*	582	*g*	191	*k*	2535	*n*		
Flow Regulation										
Total Load	326		97,507		429		8929			
Basin Emission			11	*h*	2	*l*			200	*o*

Note: Letters listed in italics under the Note column provide the background and references associated with the accompanying load
Data available; flow and concentration data available; load calculations required.
Further literature review required.
- Source does not contribute significant load of constituent in this watershed.

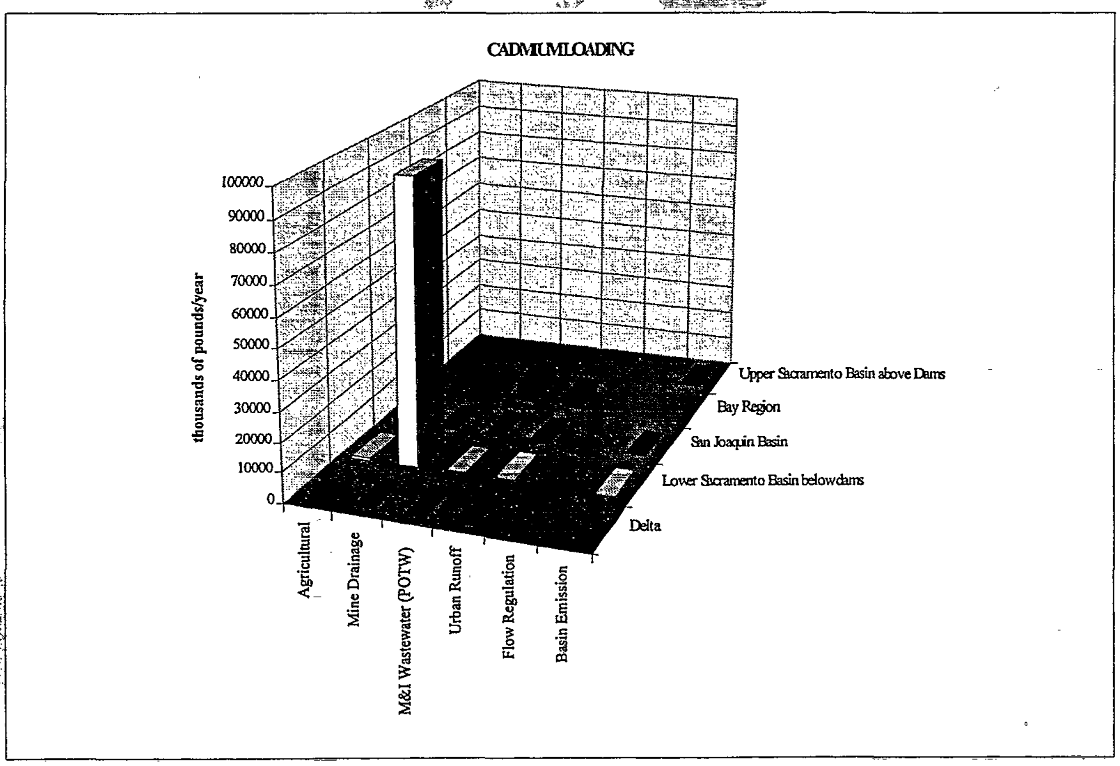

Table 4.3 Copper Loadings

COPPER LOADING TABLE										
	Copper Loading (thousands of pounds/year)									
Source	Bay Region	Note	Delta	Note	San Joaquin Basin	Note	Lower Sacramento Basin below dams	Note	Upper Sacramento Basin above Dams	Note
Agricultural							41	*e*		
Mine Drainage			4	*a*	4	*a*	274	*a*		
M&I Wastewater (POTW)	55	*g*	2	*b*			9	*b*		
Urban Runoff	73	*g*	6	*c*	9	*c*	24	*c*		
Flow Regulation										
Total Load	128		12		13		348			
Basin Emission				*d*	22	*Com a&b*	124	*Com a&b*	56	*h*

Note: Letters listed in italics under the Note column provide the background and references associated with the accompanying load

- Data available; flow and concentration data available; load calculations required.
- Further literature review required.
- Source does not contribute significant load of constituent in this watershed.

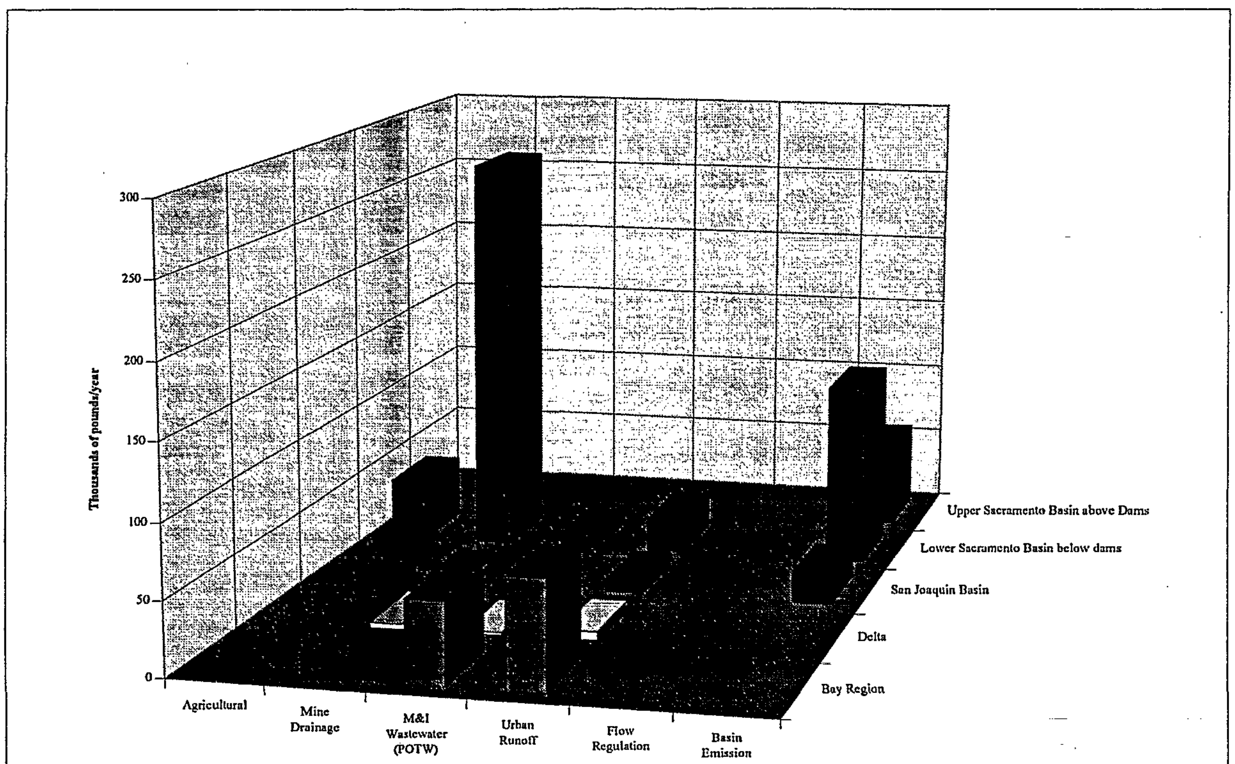

Table 4-4 Mercury Loadings

MERCURY LOADING TABLE										
	Mercury Loading (pounds/year)									
Source	Delta	Note	Sacramento Basin	Note	San Joaquin Basin	Note	Bay Region	Note	Sacramento River above dams	Note
Agricultural										
Mine Drainage										
M&I Wastewater (POTW)							1543	*a*		
Urban Runoff							330	*a*		
Flow Regulation										
Total Load							1873			
Basin Emission			2530	*Com a&b*	328	*Com a&b*			2500	*b*

Note: Letters listed in italics under the Note column provide the background and references associated with the accompanying load
- Data available; flow and concentration data available; load calculations required.
- Further literature review required.
- Source does not contribute significant load of constituent in this watershed.

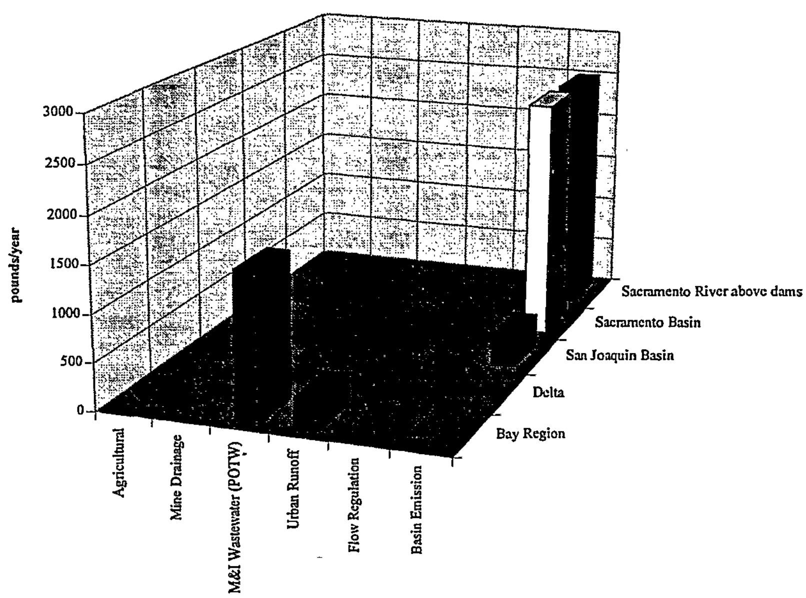

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Table 4-5 Nitrate Loadings

NITRATE LOADING TABLE								
	Nitrate Loading (thousands of pounds/year)							
Source	**Delta**	**Note**	**Bay Region**	**Note**	**Sacramento Basin**	**Note**	**Sacramento River above Dams**	**Note**
Agricultural								
Urban Runoff	77	*a*	166	*a*	1790	*b*		
Flow Regulation								
Construction								
Total Load	77		166		1790			
Basin Emission								

Note: Letters listed in italics under the Note column provide the background and references associated with the accompanying load

- Data available; flow and concentration data available; load calculations required.
- Further literature review required.
- Source does not contribute significant load of constituent in this watershed.

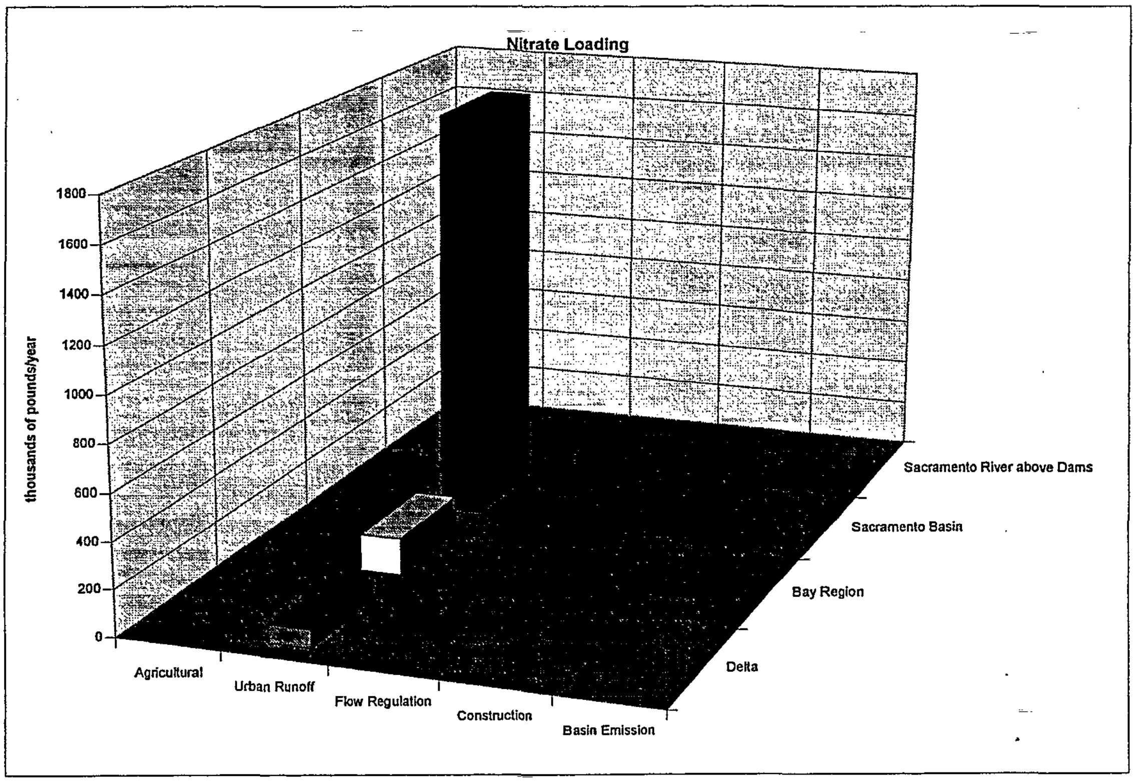
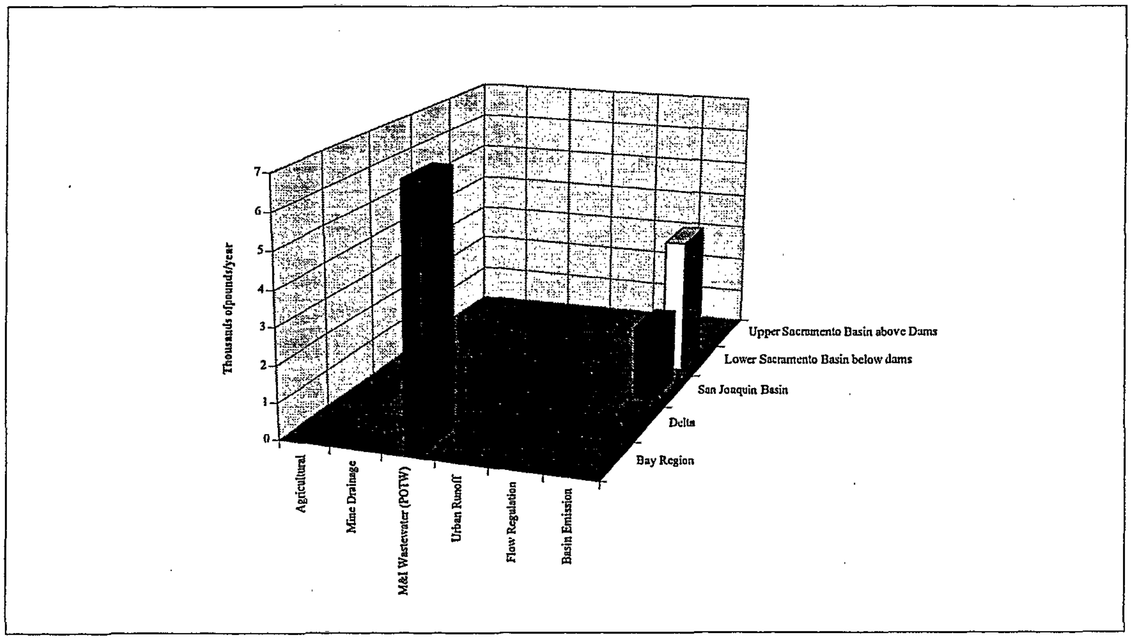


Table 4-6 Selenium Loadings

SELENIUM LOADING TABLE - 1										
	Selenium Loading (thousands of pounds/year)									
Source	**Delta**	**Note**	**Lower Sacramento Basin below dams**	**Note**	**San Joaquin Basin**	**Note**	**Bay Region**	**Note**	**Upper Sacramento Basin above Dams**	**Note**
Agricultural										
Mine Drainage										
M&I Wastewater (POTW)							7	*a*		
Urban Runoff										
Flow Regulation										
Total Load							7			
Basin Emission			4	*Com a&b*	2	*Com a&b*				

Note: Letters listed in italics under the Note column provide the background and references associated with the accompanying load
- Data available; flow and concentration data available; load calculations required.
- Further literature review required.
- Source does not contribute significant load of constituent in this watershed.



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SELENIUM TABLE - 2	
Selenium in the San Joaquin River Tributaries	
Tributary	**Dissolved Selenium Loads in Tributaries as % of those in San Joaquin River at Vernalis (1)**
Stanislaus River	2
Toulumne River	3
Salt/Mud Sloughs	71
Merced River	2
San Joaquin above Salt Slough Confluence	3

Notes:

(1) Values obtained from the U.S. Geological Survey Water Resources Investigation Report 88-4186.

The dissolved selenium loads for the tributaries to the San Joaquin River do not add up to 100% of the loads in the San Joaquin River near Vernalis because some of the load at Vernalis most likely can be attributed to sources within the river, such as selenium delivered to the San Joaquin River from sources other than the listed tributaries.

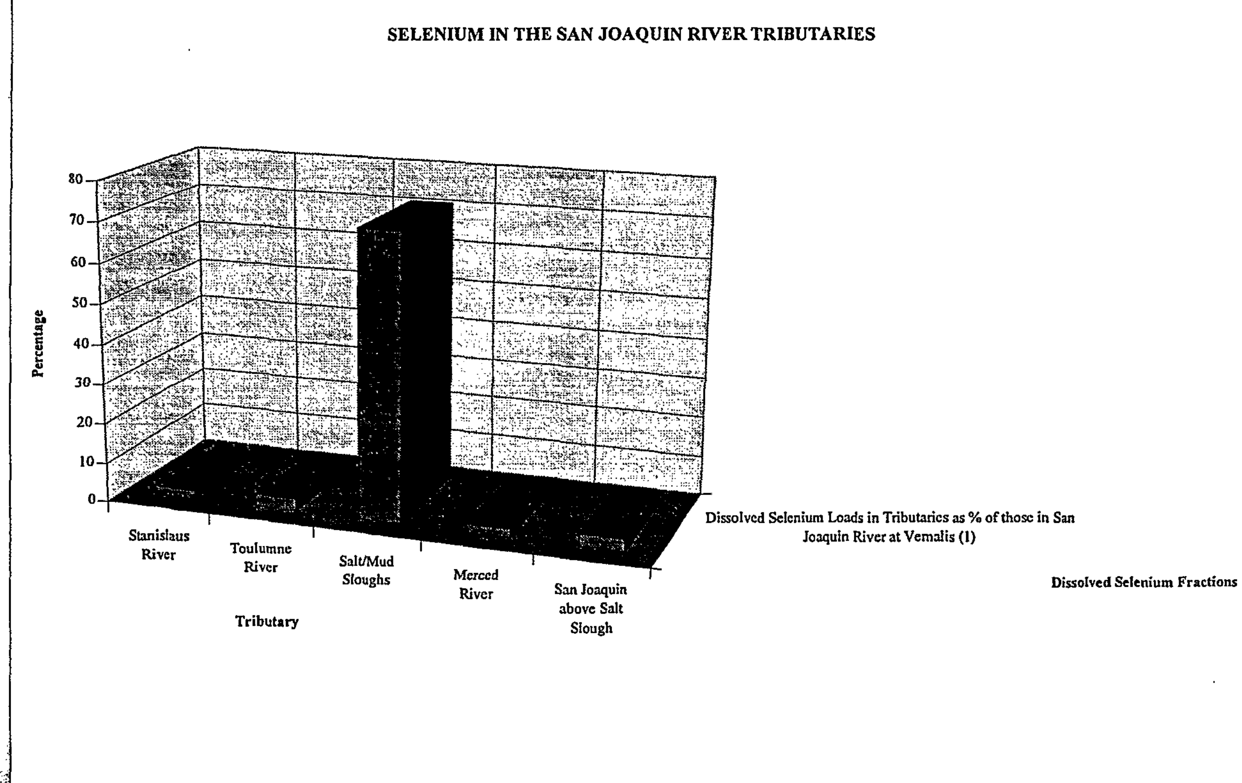

Table 4-7. Selenium Loadings from the San Joaquin Tributaries

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TOTAL DISSOLVED SOLIDS (TDS) LOADING TABLE										
	Total Dissolved Solids (TDS) Loading (thousands of pounds/year)									
Source	Delta	Note	Lower Sacramento Basin below dams	Note	San Joaquin Basin	Note	Bay Region	Note	Upper Sacramento Basin above Dams	Note
Agricultural			2,651,000	*a*	2,171,000	*d*				
Mine Drainage										
M&I Wastewater (POTW)			296,000	*b*						
Urban Runoff			42,330	*c*	296	*e*				
Flow Regulation										
Total Load			2,989,330		2,171,296					
Basin Emission			901,300	*Com a&b*	722,500	*Com a&b*				

: All numbers are rounded to significant 4 digits
Note: Letters listed in italics under the Note column provide the background and references associated with the accompanying load
Data available; flow and concentration data available; load calculations required.
Further literature review required.
- Source does not contribute significant load of constituent in this watershed.

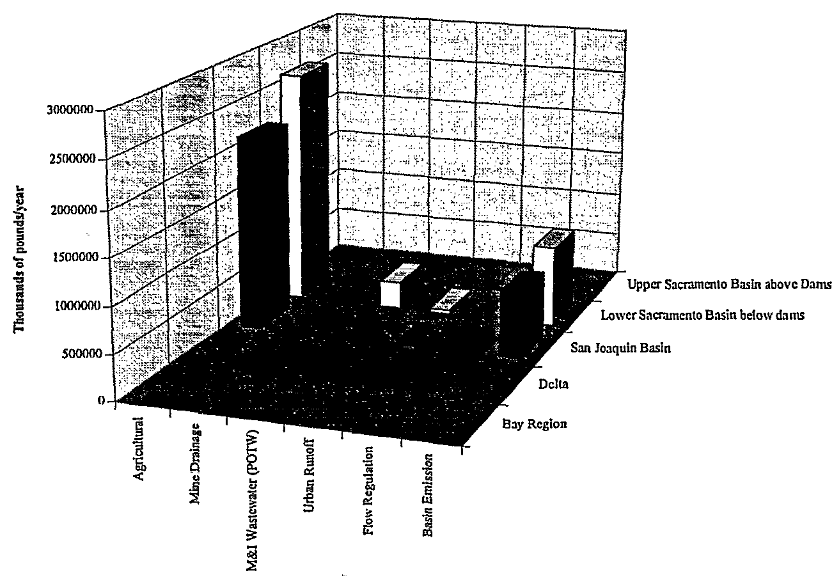


Table 4-8. Total Dissolved Solids Loadings

Table 4-9. Total Organic Carbon Loading

TOTAL ORGANIC CARBON (TOC) LOADING TABLE										
	Total Organic Carbon (TOC) Loading (thousands of pounds/year)									
Source	**Delta**	**Note**	**Lower Sacramento Basin below dams**	**Note**	**San Joaquin Basin**	**Note**	**Bay Region**	**Note**	**Upper Sacramento Basin above Dams**	**Note**
Agricultural			7706	*a*	10,764	*c*				
Mine Drainage										
M&I Wastewater (POTW)			5375	*b*						
Urban Runoff										
Flow Regulation										
Total Load			13,081		10,764					
Basin Emission			24,130	*Com a&c*	11,710	*Com a&b*				

Note: Letters listed in italics under the Note column provide the background and references associated with the accompanying load
Data available; flow and concentration data available; load calculations required.
Further literature review required.
- Source does not contribute significant load of constituent in this watershed.

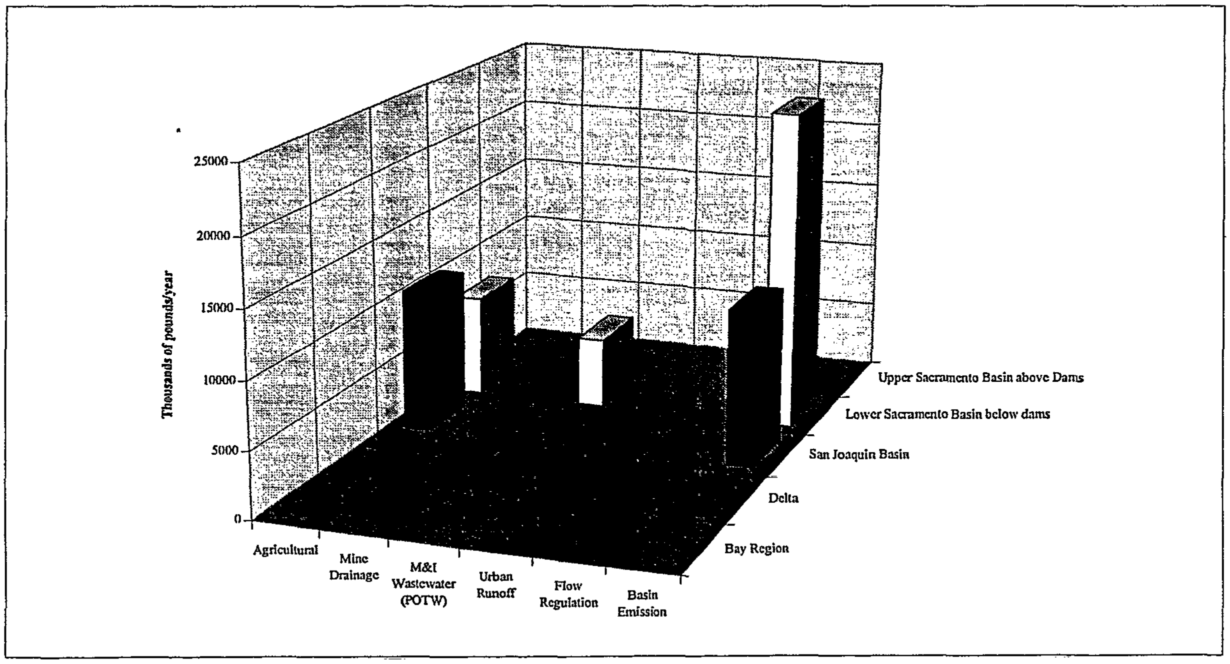


Table 4-10. Zinc Loadings

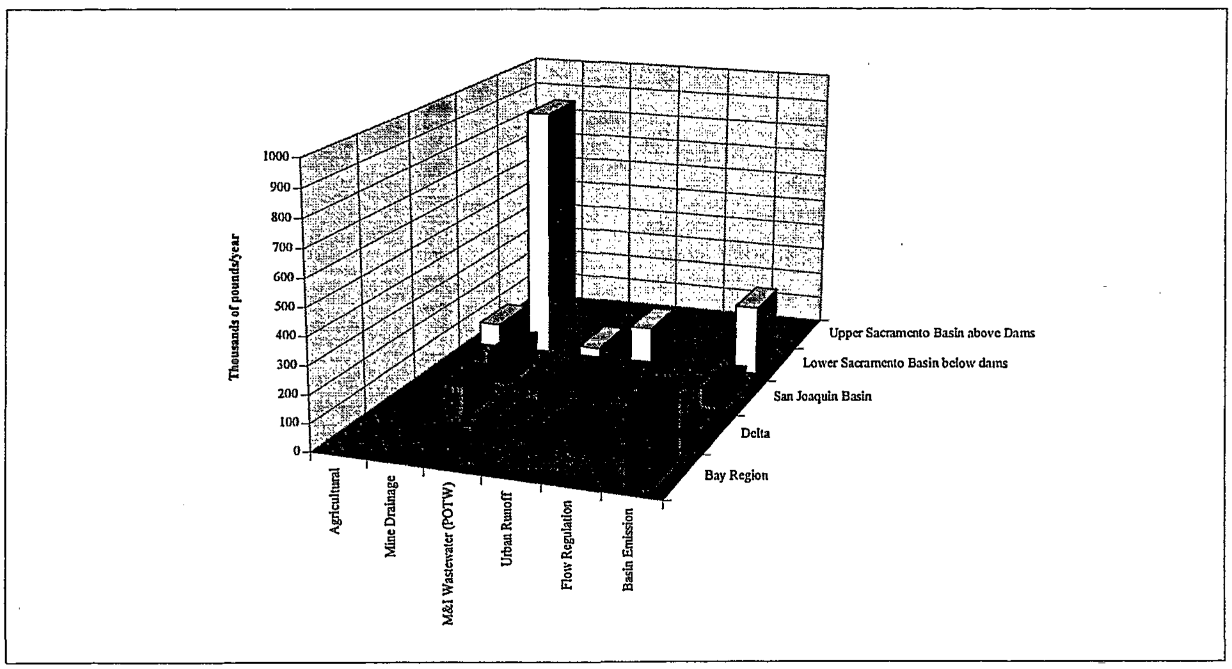
ZINC LOADING TABLE										
	Zinc Loading (thousands of pounds/year)									
Source	Delta	Note	Lower Sacramento Basin below dams	Note	San Joaquin Basin	Note	Bay Region	Note	Upper Sacramento Basin above Dams	Note
Agricultural			88	*c*						
Mine Drainage	116	*a*	930	*d*	116	*h*				
M&I Wastewater (POTW)	2	*b*	34	*e*						
Urban Runoff			131	*f*						
Flow Regulation										
Total Load	118		1183		116					
Basin Emission			255	*g*	69	*i*	279	*j*		

Note: Letters listed in italics under the Note column provide the background and references associated with the accompanying load

Data available; flow and concentration data available; load calculations required.

Further literature review required.

- Source does not contribute significant load of constituent in this watershed.



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SECTION 5

WATER QUALITY PROBLEM AREAS

Defining what constitutes a "problem" is a controversial and endlessly debatable issue. Very few of the parameters of concern have been studied sufficiently to understand their fate, transport and impact, particularly on biological systems. If a parameter is measured against an existing objective, criteria or standard a decision must be made of whether the standard is appropriate, what it is meant to protect, and what level of exceedance is relevant (e.g., duration, season, geographic location, etc.). For example, an exceedance of copper in the Upper SacramentoRiver during the fall-run chinook salmon juvenile outmigration period might be devastating to the population but during other times of the year (when fall-run are not present) there may be virtually no impact. For some parameters such as temperature and salinity extensive data has been collected. For other parameters such as pesticides, minimal information is known. Given the inherent difficulties attempting to measure data against published standards and the programmatic nature of the CALFED Water Quality Program, definition and prioritization of water quality problem areas have been based on one or more of the following criteria. These criteria have been developed through consultation with the Water Quality Technical Group, particularly the Parameter Assessment Team.

- **US EPA Section 303(d) Listing**
  Section 303(d) of the Federal Clean Water Act requires each state to develop a list, known as a 303(d) list, of water bodies that are impaired with respect to water quality. In addition to listing impaired water bodies the 303(d) list identifies the suspected major sources of parameters causing impairment.. These sources include mine drainage, agricultural drainage, urban and industrial runoff, and municipal and industrial wastewater discharges. In compliance with Section 303(d) of the Clean Water Act the San Francisco and Central Valley Regional Water Quality Control Boards in 1996, identified all impaired water bodies in California. CALFED is using this list to make a preliminary assessment of existing water quality problems (primarily environmental & recreational) in California's Central Valley and Bay-Delta.

- **Parameter Assessment Team Drinking Water Targets**
  The ability of Delta drinking water sources to be treated at reasonable cost to meet current and future federal and State health-based drinking water standards.

- **Agricultural Drinking Water Targets**
  The ability of Delta drinking water sources to sustain the productivity of agricultural lands and prevent salt contamination of soils.

- **Scientific Studies**
  Knowledge based on scientific studies and data that indicate a potentially significant problem exists.

Impaired Water Bodies

Water bodies impaired by parameters of concern, according to the 303 (d) list are shown in Figure 5-1. More detailed information pertaining to the Section 303(d) list can be found in Appendix D.

Sacramento River Basin. Several drainages in the Sacramento Basin contain metals in concentrations that may impair environmental beneficial uses. The upper Sacramento River (Shasta Dam to Red Bluff) contains elevated copper, cadmium, and zinc. Loadings to the river in this region are predominantly from mine drainage although urban runoff does contribute a measure of mass loading of these metals to the upper Sacramento drainage.

Data collected on the lower Sacramento River (Red Bluff to the Delta) indicate that this main water body is impaired with regard to environmental and recreational beneficial uses, due to elevated mercury, diazinon, and chlorpyrifos. Both the lower American River and the lower Feather River are similarly impaired. Elevated mercury in these tributaries may pose a risk to people that catch and consume fish. Elevated levels of diazinon and chlorpyrifos have been documented in the lower Feather River. In these three water bodies, urban runoff has been identified as a source of mercury, and in the lower Sacramento and Feather rivers, urban runoff has been identified as a source of diazinon and chlorpyrifos.

Other water bodies that are influenced by urban and industrial runoff include Natomas East Main Drain and Sacramento Slough. These two water bodies contain elevated levels of diazinon and chlorpyrifos. Sources include agriculture and urban runoff. Natomas East Main Drain has elevated levels of PCBs, and Sacramento Slough has elevated mercury. These bioaccumulative substances impair recreational beneficial uses (i.e., fishing) in these areas.

San Joaquin River Basin. Urban and industrial runoff contribute to the overall mass loading of parameters of concern in the San Joaquin River Basin. However, in this basin, urban runoff is not considered a major source of diazinon or chlorpyrifos relative to agricultural sources. The principal sources of identified parameters of concern are agriculture and some mines.

Delta. Runoff from the first major storm of the year in Stockton appears to annually produce an oxygen deficit causing fish kills in adjacent Delta sloughs. The cause of the deficit is not yet known (Foe, 1995). The Delta contains elevated mercury, diazinon, and chlorpyrifos. These constituents impair environmental and recreational beneficial uses. Urban runoff from cities in the Central Valley contribute mass loading of these parameters of concern.

San Francisco Bay. Numerous waterbodies drain to the San Francisco Bay Delta Estuary, many of which are listed as impaired waterbodies under Clean Water Act Section 303(d). For example, the Napa and Petaluma rivers are conveyances for a combination of urban and agricultural runoff, and may contribute pathogens, nutrients, and turbidity to the CALFED problem area. Urban runoff from cities around San Francisco Bay and San Pablo Bay is a significant source of metals to the estuary.

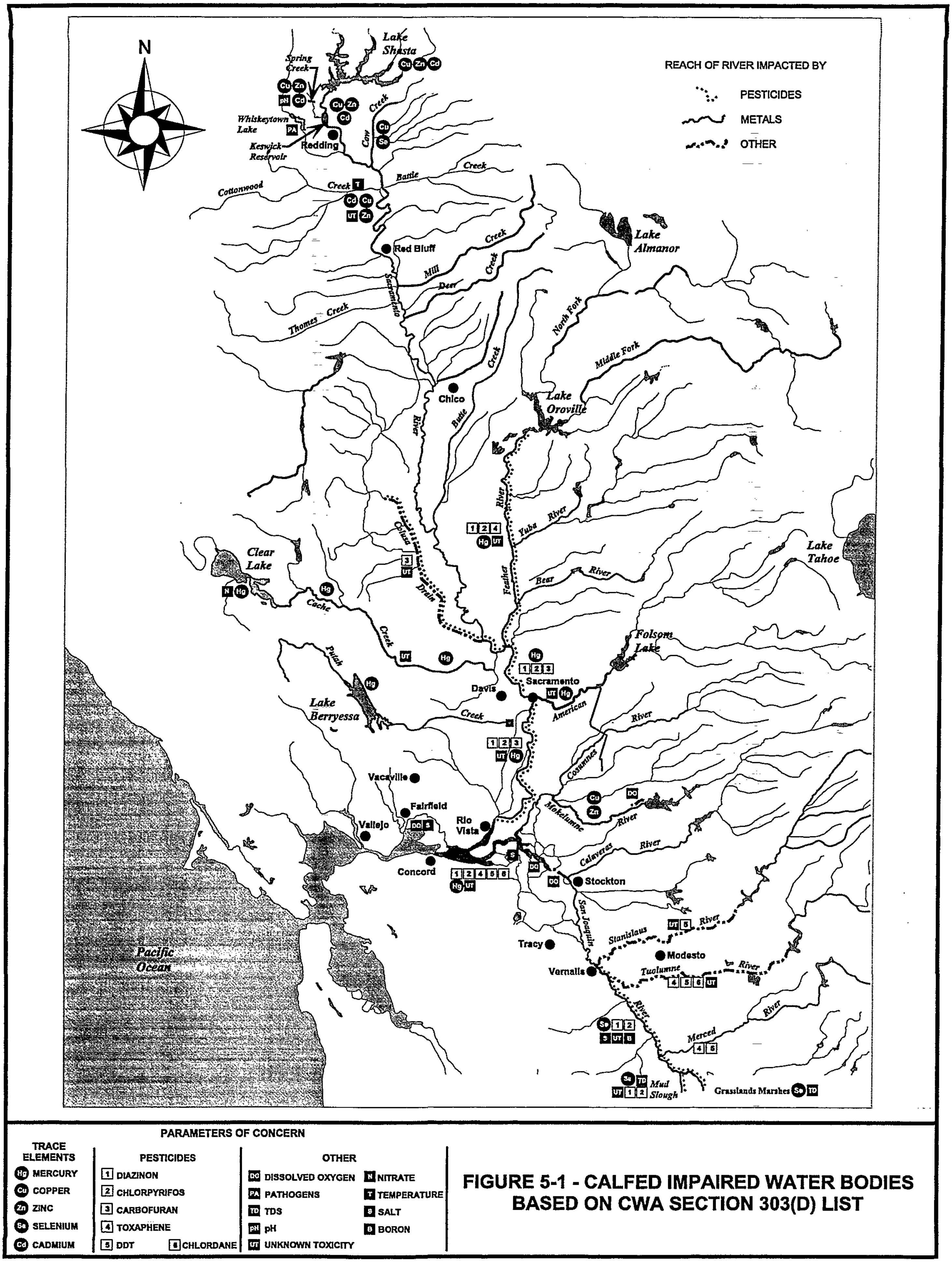

FIGURE 5-1 - CALFED IMPAIRED WATER BODIES BASED ON CWA SECTION 303(D) LIST

C—031374

SECTION 6

EXISTING PROGRAMS

Mine Drainage

Cadmium Copper and Zinc. Remediation efforts are being conducted on over 8 inactive mine sites in the Sacramento River Basin. The most well-known work is being conducted at the Iron Mountain Mine complex. Work effort includes, but are not limited to, construction of dams, installation of treatment facilities and the construction of bulkheads in the mine portals. The main focus of attention at Iron Mountain has been on the acute effects of uncontrolled spills. Additional work is being performed on other Shasta Lake Area Mines. The majority of the work to-date has focused on portal closures or treatment of mine drainage.

Regional Board staff continue to address the discharge of copper and zinc from the Walker Mine and Walker Mine Tailing sites in Plumas County. This work includes tunnel rehabilitation, infiltration control and diversion structures, and relocation of mine wastes. These projects have long term monitoring programs conducted by the Regional Board and the U.S. Forest Service.

Penn Mine, an abandoned copper mine adjacent to the Mokelumne River is scheduled for remediation by 2000. The EIS has been approved and contracts are being let to begin remediation. The mine was historically one of California's largest copper and zinc producers (Peterson, 1985). Acid mine drainage from the site has caused significant water quality impacts in the Mokelumne River and Comanche Reservoir. Concentrations of copper, cadmium and zinc in on-site ponds (whose capacity is periodically exceeded) exceed water quality criteria for aquatic life. The remediation will include complete removal and disposal of waste material to an on-site landfill and complete restoration of drainage channels. Penn Mine site remediation should result in significant (i.e., 60-80 %) reduction in copper, cadmium and zinc loadings to the Mokelumne River.

Mercury. Various technical meetings are being held to discuss mercury monitoring, assessment, and cleanup issues. One very important issue is how to compare total mercury loads to bioavailable mercury (loads) from all sources upstream of the Delta and San Francisco Bay.

The draft final report for the Sacramento River Mercury Control Project has been completed and was discussed at a recent public advisory committee meeting. The final report should be available in the spring of 1997. This report addresses mercury impacts in the lower Feather River, Yuba River, Bear River, and the Sacramento River near the City of Sacramento. The report also discusses various control strategies and recommends implementation of the mercury recycling program.

U.S. EPA has an ongoing SuperFund cleanup project at the Sulfur Bank Bine adjacent to Clear Lake. Lake County is also pursuing implementation of erosion control BMPs and monitoring of Clear Lake tributaries. This activity may address additional mercury discharges to the lake.

The Cache Creek Watershed Project has identified mercury impacts as a major water quality issue. This may lead to focusing additional resources available to the watershed stakeholders on source identification, development of cleanup alternatives, and implementation of full scale pilot projects. Monitoring activities continue to further define high mercury loads within the Cache Creek watershed. 1997 storm events have shown some of the highest mercury concentrations and loads to date.

Regional Board staff are proposing to assist Contra Costa County in preproject and postproject assessment activities to document the effectiveness of the Mount Diablo Mercury Mine pilot cleanup project.

Urban Runoff

Large Cities. In the early 1990s, cities with populations exceeding 100,000 people prepared stormwater management plans pursuant to the Clean Water Act (USC) $1,251 et seg). The plans include a number of "best management practices" (BMPs) designed to reduce stormwater pollutants. Best management practices include non-structural source control measures and structural controls. Commonly employed non-structural source controls include stenciling of catch basins and drain inlets, and public education to discourage disposal of inappropriate substances to the storm drains. Structural controls include stormwater treatment devices and elimination of illicit sanitary connections to storm drainage systems. Most current stormwater plans emphasize non-structural source controls, essentially urban "good housekeeping". They also typically include the elimination of illicit connections. Few plans call for retrofitting urban storm drainage systems with treatment devices, although some require the installation of treatment in new developments.

Small Cities. Regulations for control of stormwater discharges from cities with populations less than 100,000 have not yet been promulgated by the U.S. Environmental Protection Agency.

Industries. Most industries with the potential to contaminate stormwater runoff are required to obtain a discharge permit pursuant to the Clean Water Act. The requirement applies whether stormwater from the industry is discharged directly to the environment or to a municipal stormwater system. Permits typically require that an industry prepare, maintain, and implement a stormwater management plan that includes a variety of source control best management practices such as covering stored materials and routing heavily contaminated washwater and stormwater to the sanitary sewer.

Most urban stormwater management plans including those developed for large cities in the study area (Sacramento, Stockton, Modesto, etc.) are in the early stages of implementation.

Consequently, little data are available by which to judge their effectiveness. The data that are available indicate that source control measures do not produce major improvements in runoff quality. While education may change some human behavior, for example illicit dumping in storm drains, it is doubtful that the targeted human behaviors contribute greatly to the overall urban runoff pollutant load. It is unlikely that programs that emphasize source controls and elimination of illicit connections will substantially reduce existing urban runoff pollutant loads. Most of the more significant urban runoff pollutants are probably attributable to vehicle use, air pollutant fallout and wash-off from buildings. Such sources are beyond the range of most current regulations and are difficult to control.

Programs that involve structural controls as well as source controls are likely to be more effective than current programs. Retrofitting structural controls into existing urban development is difficult and expensive and consequently rarely undertaken. Building structural controls into new development is more practical than retrofitting existing systems.

Wastewater Discharges

There are current programs through the Regional Water Quality Control Boards and the Coast Guard to regulate and control discharges.

The Regional Water Quality Control Board for the Central Region has actively evaluated the water quality of the Delta and its tributaries and has established an "Inland Surface Water Plan." Every municipality, agency, district and industry that produces a wastewater discharge must complete a Report of Discharge and request a discharge permit. The CVRWQCB then reviews the Report of Discharge and issues a discharge permit. Entities that discharge to a surface water must also obtain an NPDES permit. This is issued by the Environmental Protection Agency (EPA).

The permitted entity must periodically file records that describe their actual discharges. If at any time they have not met their discharge requirement, they are required to notify the CVRWQCB. The facility is also inspected and evaluated on a regular basis.

If a municipality, agency or district has industrial customers they must develop an industrial pre-treatment program to monitor and control industrial discharges that may affect the operational effectiveness of the treatment facility, impact the health and welfare of the community or impact the ecology of the discharge site (surface water or groundwater). Specific limits on discharge become a part of the industries use permit.

The effectiveness of the current CVRWQCB programs at limiting loadings of municipal and industrial discharges to the Delta is thought to be very high. However, the effectiveness of the programs to control boat discharges is unknown. Each municipality listed above was interviewed in regard to their handling of the parameters of concern. The following paragraphs briefly describe the results of these interviews.

Cadmium, Copper, Zinc and Mercury. Each of the communities surveyed either monitors for these constituents or requires industries to monitor and report metals levels in the waste stream as a part of their industrial pretreatment program. There are known background levels of some metals in the local drinking water in many areas, for example, Redding, Stockton and Sacramento have reported metals in the water supply, mainly zinc and copper. Modesto is the only plant with current discharge limits on these metals. Although much of the metals in the plant influent is removed in the biosolids, none of the plants have specific processes to remove them.

The Stockton Wastewater Treatment Facility recently completed a mercury study. The discharge of total, dissolved and methyl mercury from the facility to the San Joaquin River was investigated. The final report for this study provides additional insight into other potentially significant discharges from the treatment facility and other sources to the Delta.

Chlorpyrifos and Diazinon. There are currently no discharge limits on Chlorpyrifos and Diazinon. They have not been considered as constituents in the plant influent. Sacramento Regional Waste Water Treatment Plant has become aware of a concern of the presence of these pesticides and began testing for them in 1996. This is the only facility currently monitoring regularly for these chemicals.

Ammonia and Nitrate. None of the plants currently have processes designed to control ammonia. Modesto has a discharge requirement on ammonia and needs to occasionally reduce discharge flows to remain in compliance. Stockton has an agreement with the RWQCB to develop a plan and facilities to reduce ammonia levels. The treatment plants typically monitor for nitrates but none have specific discharge limits, although Modesto has treatment facilities for nitrogen removal.

Dissolved Oxygen and Temperature. Although dissolved oxygen level (DO) and temperature are important parameters in the river, the treatment plants do not generally have a problem meeting the requirements. All the plants are required to maintain the existing river environment by not elevating the river temperature or lowering the dissolved oxygen levels. Typically the temperature requirement prohibits discharges that would raise the temperature at any point in the river by more than 4° F, or in 25% of a cross section of the river by more than 1° F and the effluent temperature cannot be more than 20° F above the ambient temperature of the river. The treatment plants monitor the river upstream and downstream of their discharge points and have generally not had difficulties meeting these requirements. The Stockton plant has 640 acres of detention ponds in which the plant effluent reaches near river temperature before it is discharged. The Sacramento Regional plant has a specific 14:1 dilution requirement and has also been granted a waiver of the 1° requirement during very cold weather and has holding ponds that are utilized to reduce discharge flow and/or lower effluent temperature before discharging to the river necessary.

None of the plants surveyed had had difficulty meeting the DO requirements. The Modesto plant has floating aerators to maintain sufficient DO levels. In Stockton, the RWQCB adopted water quality objectives for the San Joaquin River to be met by the year 2005 which were the rationale to tighten the requirements for Stockton's permit. The permit was ammended to lengthen the period that tertiary treatment would be required and added ammonia limits. The City appealed this because they believe they have demonstrated that they are only a small part of the problem. The requirements have been stayed, and they are currently only required to monitor DO levels upstream and downstream of their discharge point.

Pathogens. Pathogens are controlled by chlorine at all plants surveyed. Permit requirements are typically in terms of total coliform measured by most probable number per liter (MPN) and must be less than 500 MPN daily and maintain a monthly median less than 23 MPN.

Salinity (TDS). A few facilities include monitoring for TDS as part of their industrial pretreatment program. In some areas, such as Tracy, there is a significant amount of TDS in the drinking water supply. There are no discharge limits on TDS, and there are no facilities specifically designed to remove it. Stockton's permit includes language that requires that they "minimize" TDS in the effluent. Most agencies regularly sample for TDS but do not attempt to control it.

Agricultural Drainage

Some of the programs, practices, and regulations that influence agricultural drainage water quality include the following:

- **The San Joaquin Valley Drainage Implementation Program,** Multi-agency
- **The Drainage Program and its constituent programs,** Department of Water Resources
- **The Rice Herbicide Program,** Initiated by the California Department of Pesticide Regulation
- **Federal and state restrictions** on the use and handling of pesticides.
- **Water contract requirements**
- **Voluntary implementation** of IPM and BMP's to reduce farming costs and pollution sources.
- **Local district programs,** such as Westlands Water District's Groundwater Management Plan
- **Habitat Enhancement Landowner Program,** Western Growers Association.

Other recommendations include those developed by a series of Technical Advisory Committees to the California State Water Resources Control Board, covering the following areas:

- Irrigated agriculture
- Pesticide management
- Dairy and feedlot management
- Rangeland management
- Plant nutrient management

Three current programs will be discussed briefly:

The Drainage Reduction Program, a sub-program of the Drainage Program at the Department of Water Resources: This program examined the potential of a number of technologies and management tools to reduce subsurface agricultural drainage. Examples include improved furrow irrigation, shallow groundwater management, tiered water pricing, irrigation efficiency, and emerging irrigation technologies. The Supplemental Information section provides a summary of funded projects. A series of reports provide a substantial basis for evaluating the tested

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technologies and management tools.

The Rice Herbicide Program, initiated by the California Department of Pesticide Regulation in 1984. The herbicides are not included among the parameters of concern, but this may be largely due to this program and the efforts made by the rice industry to reduce herbicide concentration in surface drainage. This program included establishment of rice herbicide performance goals for the Colusa Basin Drain and the Sacramento River. Holding times for rice irrigation water after herbicide application were specified, and the rice industry installed a variety of innovative irrigation return flow control systems. Resulting reductions in rice herbicide concentrations were dramatic, and generally in compliance with increasingly stringent performance goals. The program, context, and results are described in the Supplemental Information section.

Habitat Enhancement Landowner Program, Western Growers Association, California Farm Bureau Federation, and California Cattlemen Association. Under this program, landowner/growers implement habitat enhancement on their property, and receive a general incidental take permit to protect them from Endangered Species Act enforcement that might result from the increased wildlife presence in the enhanced habitat. With regard to drainage, habitat enhancement can play an important role, if it is designed to do so. For example, filter, or buffer strips (land with relatively dense vegetative cover) can remove sediment and associated parameters of concern from runoff, and wetlands allow for sediment settling and decomposition of organic constituents, and immobilization or uptake of other parameters of concern. This program is in the early stages of development, but has wide support and substantial promise.

SECTION 7

ACTION STRATEGIES

Action strategies have been developed by the Water Quality Program to address water quality problems in the Delta and its tributaries. The strategies are recommended actions that either improve source water quality by reducing loadings from the sources of water quality problems (e.g., mine drainage, agricultural drainage, urban and industrial runoff, and municipal and industrial wastewater treatment facilities), upgrade water treatment plants, or change water management practices.

Action strategies to address water quality problems include a combination of research, pilot studies and full-scale actions. For some parameters, such as mercury, there is little understood about its sources, the bioavailability of the various sources, and the load reductions needed to reduce fish tissue concentrations to levels acceptable for human consumption. For this parameter further study is recommended before full-scale actions are taken. For other parameters, such as selenium, sources are better documented, and source control or treatment actions can be taken with a reasonable expectation of positive environmental results.

Performance targets have been established to measure the effectiveness of actions in improving water quality. Performance targets may be quantifiable reductions in loadings of parameters. For example, the target for copper in the Sacramento River is to reduce copper loadings in the Upper Sacramento River from 65,000 pounds to 10,000 pounds per year. For actions that recommend further study of a parameter the performance target may be a focussed outcome. For example, an action for mercury is further research to better understand the sources and mechanisms of mercury accumulation in the Delta. The performance target is a targeted action plan that specifies selection and prioritization of the most effective mercury remediation actions.

Indicators of success are generally numerical or narrative water quality targets have been developed for each parameter of concern. These targets relate to acceptable in-stream concentrations of parameters. They will be used to gauge action and alternative effectiveness at protecting beneficial uses. Targets are based on Water Quality Control Plans (Basin Plans) of the Bay Area and Central Valley Regional Water Quality Control Boards or U.S. Environmental Protection Agency ambient water quality objectives, standard agricultural water quality objectives, and target source drinking water quality ranges as defined by technical experts.

Individual programmatic actions may vary in cost, technical feasibility, and other respects that would affect the final choices for implementation of actions. Actions will therefore be subjected to pre-feasibility analysis to determine which programmatic action are most appropriate to be carried forward toward implementation. This work has begun and will continue into Phase III of the CALFED Program. Full feasibility analysis in conjunction with project-specific environmental documentation will be performed in Phase III.

Summary of Action Strategies

Following is a summary by geographic region of some of the major strategies that make up the CALFED Water Quality Program.

Delta

Actions strategies to address water quality problems in the Delta address urban and industrial runoff, municipal and industrial wastewater, agricultural drainage, and source control and treatment. Following is a description of the main action strategies for each of these sources.

Mine drainage actions will reduce mercury loadings to the Delta from abandoned and inactive mines. These actions include source control and treatment measures. Actions for mercury occur throughout the basin and are primarily being addressed through a system-wide research-program that will attempt to identify bioavailable forms of mercury, sources of the bioavailable forms and an action plan to reduce the loadings of these forms. Pilot scale actions are recommended for mines that drain mercury to Cache Creek and the Yolo Bypass.

Urban and industrial runoff actions will help to reduce toxicity from the pesticides chlorpyrifos and diazinon, copper, and oxygen depletion in the Delta, and to reduce pathogens. Actions include both source control and treatment measures.

Municipal and industrial discharge actions will help to reduce pathogens and oxygen depletion. These actions include source control and treatment measures including improved management of boat discharges and additional source control or treatment at wastewater treatment plants.

Agricultural drainage actions will reduce toxicity from the pesticide carbofuran, chlorpyrifos, and diazinon in the Delta. Actions are primarily source control measures such as best management practices (BMPs).

Actions to improve the quality of drinking water sources include relocation of water supply intakes to avoid areas of high salinity, total organic carbon, and turbidity.

Actions to improve drinking water quality include upgrades to treatment processes to improve disinfection while reducing production of unwanted disinfection byproducts.

Actions to address unknown toxicity focus on development of a comprehensive monitoring, assessment, and research program to identify toxicities, the sources of these toxicities, and action plans to address unknown toxicity in the Delta and its tributaries.

Sacramento Basin

Action strategies in the Sacramento Basin predominantly include mine drainage actions with some agricultural drainage and urban and industrial runoff actions. Following is a description of the main action strategies for each of these sources.

Mine drainage actions will reduce mercury, cadmium, copper, and zinc loadings to the Sacramento River and its tributaries from abandoned and inactive mines. These actions include point source and non-point source measures. Actions for cadmium, copper, and zinc are focussed at mine sites that drain into the upper Sacramento River. Actions for mercury occur throughout the basin and are primarily being addressed through a system-wide research-program to identify bioavailable forms of mercury, sources of the bioavailable forms and an action plan to reduce the loadings of these forms.

Urban and industrial runoff actions will reduce toxicity of the pesticide chlorpyrifos and diazinon in the Sacramento River and its tributaries from urban areas. These actions will include implementation of pesticide usage BMPs in urban areas.

Agricultural drainage actions will reduce toxicity from the pesticides carbofuran, chlorpyrifos, and diazinon in the Sacramento River and its tributaries from agricultural areas. Actions are primarily source control measures such as best management practices (BMPs), especially from farm areas that drain to the Feather River, Colusa Basin Drain, and mainstem Sacramento River.

Actions to address unknown toxicity focus on development of a comprehensive monitoring, assessment and research program to identify toxicities, the sources of these toxicities, and action plans to address unknown toxicity in the Sacramento River and its tributaries.

San Joaquin Basin

Action strategies in the San Joaquin Basin predominantly include agricultural drainage actions with limited mine drainage actions. Following is a description of the main action strategies for each of these sources.

Subsurface agricultural drainage discharged to the San Joaquin River from the Grasslands area are perhaps the most significant cause of water quality problems, specifically selenium and salinity (TDS, chloride, bromide), in the River. CALFED agricultural drainage actions include drainage reduction and reuse, timed drainage release, drainage treatment to reduce trace elements and other contaminants, salt separation and utilization and land use changes to reduce drainage quantities. Agricultural drainage actions will reduce toxicity from the pesticides chlorpyrifos and diazinon in the San Joaquin River and its tributaries from agricultural areas. Actions are primarily source control measures such as best management practices (BMPs) particularly in farm areas that drain to Mud and Salt sloughs, and the San Joaquin River.

Actions to address mine drainage associated with loadings of cadmium and zinc to the San Joaquin Basin (specifically the Mokelumne River) have been undertaken as part of the Penn Mine Remediation Plan. However, mercury loadings continue to be a problem in the basin. Actions for mercury occur throughout the basin and are primarily being addressed through a system-wide research-program that will attempt to identify bioavailable forms of mercury, sources of the bioavailable forms and an action plan to reduce the loadings of these forms.

Actions to address unknown toxicity focus on development of a comprehensive monitoring, assessment and research program to identify toxicities, the sources of these toxicities, and action plans to address unknown toxicity in the San Joaquin River and its tributaries.

Mine Drainage

Action

Reduce toxic effects of cadmium, copper, and zinc loadings to the Delta and its tributaries by source control or treatment of mine drainage at inactive and abandoned mine sites. Action targeted at the Upper Sacramento River and tributaries to the Upper Sacramento River that are major contributors of copper, cadmium and zinc loadings.

Methods

- Source control methods include capping tailings piles, removing tailings piles, diverting water courses from metal sources, sealing mines, removing contaminated sediments, and similar measures to prevent metals from leaching or draining into water bodies.
- Treatment methods involve collecting and treating mine drainage to remove metals and neutralize acidity.

Performance measure

- Reduction in annual copper loadings (during an average water year) to the Upper Sacramento River from approximately 65,000 pounds to 10,000 pounds.

Indicator of success

Achievement of Basin Plan objectives for cadmium, copper and zinc in the Sacramento River above Hamilton City.

Action

Reduce toxic effects of mercury loadings to the Delta and its tributaries by source control and/or treatment of mine drainage at inactive and abandoned mine sites.

Methods

- Development of a system-wide research program to identify bioavailable forms of mercury, sources of the bioavailable forms and an action plan to reduce loadings of these forms to the Delta and its tributaries.
- Development of pilot scale projects to determine feasibility of mercury contaminated sediment cleanup. Recommend action be targeted at the Cache Creek and its tributary

watersheds.

- Treatment of mercury contaminated mine drainage. Recommend action be targeted at the Cache Creek Watershed and Mt. Diablo mine areas.

Performance measures

- Improved understanding of sources and mechanisms of mercury bioaccumulation in the Delta.
- Improved understanding of the cost/benefit associated with remediation of mercury contaminated sediment.
- A targeted action plan that specifies selection and prioritization of actions to remediate mercury loadings to the Delta and its tributaries.
- Reduction in mercury loadings to Cache Creek.

Indicators of success

- Achievement of US EPA 304(a) guideline for mercury in the Delta and its tributaries.
- Removal of fish health advisories.

Urban and Industrial Runoff

Action

Reduce toxic effects of copper, zinc and cadmium loadings to the Delta and its tributaries from urban and industrial runoff

Methods

- Enforcement of existing source control regulations.
- Provision of incentives for additional source control of urban and industrial runoff, particularly those areas that have runoff associated with vehicle usage.

Performance measure

- Improved understanding of the sources and mechanisms for bioaccumulation of cadmium, copper, and zinc in the Delta.
- Reduction in copper loadings at selected stormwater monitoring stations.

Indicator of success

- For copper and zinc achievement of Basin Plan objectives in the Delta and Sacramento River and its tributaries, US EPA 304(a) guidelines in the San Joaquin River and its tributaries
- For cadmium achievement of Basin Plan objectives in the Sacramento River and its tributaries and west of Antioch Bridge in the Delta, US EPA 304(a) guidelines in the San Joaquin River and its tributaries and east of Antioch Bridge in the Delta.

Action

Reduce (or eliminate) toxicity from the pesticides chlorpyrifos and diazinon in the Delta and its tributaries through source control of urban and industrial runoff.

Methods

- Provide regulatory incentives and financial incentives for implementation of additional urban and industrial runoff source control measures.

- Provision of source control incentives, such as additional education for homeowners on pesticide usage and incentives for pesticide users to increase implementation of best management practices including integrated pest management.
- Work with watershed stakeholder groups on source control education.

Performance measure

- Improved understanding of the toxicity and sources and mechanisms of chlorpyrifos and diazinon transport into the Delta.
- Reduced toxicity at selected stormwater monitoring locations measured by improved survivability from a three-species test.

Indicator of success

- Reduced toxicity from chlorpyrifos and diazinon in the Delta and its tributaries.

Action

Reduce the toxic effects of nutrient loadings and consequently, oxygen depletion in the Delta (specifically near Stockton) through source control of urban and industrial runoff.

Methods

- Enforcement of existing source control regulations including implementation of best management practices.
- Provision of incentives for additional source control including best management practices and better planning of new developments (e.g., design of storm drainage systems that target maximum infiltration of stormwater into the ground or on-site or regional stormwater sedimentation facilities that detain the majority of stormwater for at least 8 hours,etc.) and public education.

Performance Measure

- Improved understanding of the sources and mechanisms for nutrient transport in the Delta.
- No measurable impacts to fish from low dissolved oxygen levels in the Lower San Joaquin River.

Indicator of Success

- Achievement of Basin Plan objectives for dissolved oxygen in the Delta and its tributaries, particularly in the Lower San Joaquin River.

Action

Reduce the impacts of sediment loading, and subsequent turbidity to the ecosystem of the Delta and its tributaries and to urban drinking water sources in the Delta, through source control of urban and industrial runoff.

Methods

- Better enforcement of existing source control regulations for construction sites. May include development of ordinances and other measures.

- Education of construction personnel on impacts of construction site discharges.
- Evaluate the feasibility of detention basin in new developments for control of sediment and its associated pollutants.

Performance Measure

- Decreased turbidity levels in urban runoff discharges to the Delta and its tributaries and at Delta water supply intakes.
- Increased juvenile anadromous fish production in areas downstream of new developments on Delta tributaries where anadromous fish are known to spawn.

Indicator of Success

- Achievement of a 50 NTU monthly median at drinking water intakes.
- Achievement of Basin Plan objectives for turbidity.

Action

Evaluate the loadings of TOC, salinity, and pathogens in urban runoff and assess the need for source control measures to reduce these parameters of concern to drinking water supplies.

Methods

- Include monitoring for TOC, salinity, and pathogens in stormwater and dry season runoff as part of the comprehensive monitoring, assessment, and research program.
- Evaluate the relative loading of these constituents in urban runoff, wastewater discharges, and agricultural drainage discharges.

Performance Measures

- Improved understanding of the sources of TOC, salinity, and pathogens in the Delta and its watersheds.
- Reduced TOC, salinity, and pathogen loads entering the Delta and its tributaries.
- Reduced peaks in salinity concentrations at water supply intakes.

Indicator of Success

- Achievement of water supply target levels for TOC (3.0 mg/L, quarterly average), pathogens (<1 oocyst/100L), and salinity (220 mg/L, 10 year average).

Wastewater and Industrial Discharges

Action

Reduce the impact of domestic wastes and hence pathogens to Delta urban drinking water supplies and recreational water uses, from boat discharges within the Delta and Delta tributaries.

Methods

- More extensive enforcement of boat domestic waste discharge regulations.
- Extensive boater education campaigns.
- Installation of more extensive, better, and more economical pumpout stations.
- Installation of more public toilet facilities.

Performance Measure

- Quantifiable records from pumpout facilities that show increased usage by boaters. Usage should match expected boater domestic waste quantities.
- Number of public workshops and other outreach activities.
- Number of new pumpout and toilet facilities installed.

Indicator of Success

- Reduced bacteriological counts in marinas and other recreational areas.
- Achievement of water supply target levels for pathogens (<1 oocyst/100L).

Action

Reduce the toxic impacts of oxygen depleting substances and copper and mercury loadings to the Delta through cost effective source control and treatment of industrial and municipal wastewater discharges. Action for oxygen depleting substances should be targeted at the Lower San Joaquin River and copper and mercury loadings at the Suisun Bay and Carquinez Straight area.

Methods

- Financial and regulatory incentives provided to industries to pre-treat discharges containing copper, mercury, and oxygen depleting substances.
- Financial and regulatory incentives provided to municipalities to provide improved wastewater effluent treatment and to identify and implement opportunities for wastewater effluent reclamation and reuse.
- Treatment of a portion of upstream municipal wastewater effluent in wetlands.

Performance Measures

- Reduction in nutrient loadings from Delta municipal wastewater treatment facilities.
- Reduction in copper and mercury loadings from Delta wastewater treatment plants.

Indicator of Success

- Achievement of Basin Plan objectives for dissolved oxygen in the Lower San Joaquin River.
- Achievement of applicable Basin Plan objectives or US EPA 304(a) criteria for copper and mercury in the Delta.

Action

Reduce the toxic impacts of selenium loadings to the Delta through source control and treatment of industrial discharges. Action should be targeted at industries that discharge selenium to the Suisun Bay and Carquinez Straight area.

Method

- Additional treatment of oil refinery discharges in the western Delta for selenium removal.

Performance Measure

- Reduced selenium loadings to the western Delta

Indicator of Success

- Reduction in tissue concentrations of selenium to levels that are not harmful to aquatic organisms in the western Delta.

Action

Evaluate the loadings of TOC, salinity, and pathogens from wastewater and industrial treatment plant discharges, and assess the need for source control measures to reduce these parameters of concern to urban water supplies.

Methods

- Include monitoring for TOC, salinity, and pathogens in wastewater and industrial treatment plant discharges as part of the comprehensive monitoring, assessment, and research program.
- Evaluate the relative loading of these constituents in urban runoff, wastewater discharges, and agricultural discharges.

Performance Measures

- Improved understanding of the sources of TOC, salinity, and pathogens in the Delta and its tributaries.
- Development of appropriate actions to reduce TOC, salinity, and pathogen loads entering the Delta and its tributaries.

Indicator of Success

- Achievement of water supply target levels for TOC (3.0 mg/L, quarterly average), pathogens (<1 oocyst/100L), and salinity (220 mg/L, 10 year average).

Action

Reduce the toxic effects of <u>ammonia</u> entering the Delta and its tributaries from waste water treatment plant discharges through improved treatment.

Method

- Provide incentives for improved waste water treatment facilities and processes.

Performance Measure

- Reduced toxicity due to ammonia in Delta channels and lower reaches of its tributary streams.

Indicator of Success

- Improved survival of test organisms in three-species toxicity bioassays, and indications through the toxicity identification evaluation testing that ammonia is not a significant cause of toxicity in Delta channels.

Agricultural Drainage

Action

Reduce the toxic effects of <u>selenium</u> loadings to the Lower San Joaquin River and Delta by controlling sources of selenium in agricultural sub-surface drainage.

Methods

- Change use of lands that are major sources of selenium through voluntary landowner participation and by compensated arrangements to reduce drainage volumes.

- Reduce drainage flows through increased water use efficiency.
- Evaluate feasibility of treatment options and treat drainage for selenium removal where feasibility.
- Evaluate land management programs that include planting crops such as safflower, that use water from the high water table.

Performance Measure

- Reduced selenium loadings to the San Joaquin River watershed.

Indicator of Success

- Reduction in the tissue concentrations of selenium to levels that are not harmful to aquatic organisms.

Action

Reduce salinity impacts to Delta urban and agricultural source water quality through source control and treatment of agricultural surface and sub-surface drainage in the San Joaquin River watershed.

Methods

- Improved source irrigation water quality in sub-surface drainage areas.
- Concentration and safe disposal of agricultural drainage in evaporation ponds.
- Treatment of agricultural drainage by reverse osmosis, constructed wetlands, and continued research in other treatment techniques.
- Time agricultural drainage discharges to coincide with periods when dilution flow is sufficient to achieve water quality target ranges for salinity.

Performance Measures

- Reduced salinity loads entering the San Joaquin River from adjacent lands.

Indicators of Success

- Reduced salinity in the San Joaquin River near Vernalis, where the River flows into the Delta.
- Achievement of CALFED Water Quality targets for salinity.

Action

Reduce toxicity from agricultural pesticides such as carbofuran, chlorpyrifos, and diazinon that have been identified as causing toxicity to aquatic life in the Delta.

Method

- Provide regulatory and financial incentives for implementation of agricultural drainage source control measures that include incentives for pesticide users to increase implementation of best management practices including integrated pest management and grower education.
- Provide financial incentives and assistance for pilot-scale testing of best management practices to control pesticide discharges in agricultural surface runoff.
- Work with watershed stakeholder groups on source control education..

Performance Measures

- Reduction (or elimination) of toxicity in Delta channel waters and tributary waters..

Indicator of Success

- Improved survival of test organisms in three-species toxicity bioasssays, and indications through the toxicity identification evaluation testing that pesticides are not a significant cause of toxicity in Delta channels.
- Achievement of Basin Plan objectives for carbofuran when they are promulgated.

Action

Reduce the impacts of sediment loading and subsequent to the ecosystem of the Delta and its tributaries and to urban drinking water sources in the Delta, through agricultural runoff control measures.

Method

- Provide incentives and assistance for implementation of agricultural land use practices and improved irrigation strategies to reduce soil erosion, and for installation of buffer strips.

Performance Measures

- Reduction of sediment loading to the Delta and its tributaries from agricultural areas with high erosion rates.

Indicator of Success

- Achievement of a 50 NTU monthly median at drinking water intakes in the Delta and tributaries.
- Achievement of CALFED targets for turbidity.

Action

Reduce the impacts of TOC loading on drinking water supplies by controlling TOC discharges from the Delta islands.

Method

- Provide financial assistance and incentives for pilot-scale testing and implementation of water management practices and cropping patterns to reduce contributions of TOC from Delta islands.
- Change or modify land use on Delta islands with peat soils.
- Reduce concentration of TOC in agricultural drainage water through treatment of drainage water prior to discharge.

Performance Measures

- Reduction in TOC loads to the Delta by as least 25 percent. (CMARP will provide information on whether a 25 percent reduction in conjunction with other source control measures will allow the target level of <3.0 mg/L to be met).

Indicator of Success

- Achievement of a TOC target level of <3.0 mg/L quarterly average at drinking water supply intakes..

Action

Reduce the toxic effects of ammonia entering the Delta and its tributaries through source control of agricultural surface drainage.

Method

- Provide incentives for implementation of best management practices at dairies, other animal operations, and fertilized lands in the watersheds that discharge into the Delta, including the North Bay, and the lower reaches of the Sacramento and San Joaquin Rivers, and westside stream tributaries to the Delta.

Performance Measures

- Reduced toxicity due to ammonia in Delta channels and lower reaches of its tributary streams.

Indicator of Success

- Improved survival of test organisms in three-species toxicity bioasssays, and indications through the toxicity identification evaluation testing that ammonia is not a significant cause of toxicity in Delta channels.
- Achievement of US EPA 304(a) guidelines for ammonia in the Delta and its tributaries.

Action

Reduce the impacts of pathogens on drinking water supplies by controlling sources of pathogens from rangelands, dairies, and confined animal facilities.

Method

- Provide financial incentives and educational assistance for pilot-scale testing and implementation of best management practices that control pathogen discharges form rangelands, dairies, and confined animal facilities.
- Provide financial resources for the Regional Board to more effectively regulate all dairies with waste discharge requirements.

Performance Measures

- Reduction in pathogen loads entering the Delta and its tributaries from confined animal facilities and rangelands..

Indicator of Success

- Achievement of pathogen target level (<1 oocyst/100L at drinking water supply intakes.

Water Treatment

Action

Improve treated drinking water quality (including reduction in formation of disinfection by-products) through treatment to reduce concentrations of total organic carbon, pathogens, turbidity, and bromides.

Methods

- Incentives for the addition of enhanced coagulation, ozone, granular activated carbon filtration and/or membrane filtration facilities to the water systems treating water from the Delta.

Performance Measures

- Reliably meet current and future drinking water standards.

Indicator of Success

- Absence of waterborne disease outbreaks and quantitative evidence of treatment success by measures such as bacteria counts, pathogen counts, and measurements of organic carbon, disinfection byproducts, and turbidity.

Action

Improve total organic carbon, pathogens, turbidity and bromides at domestic water supply intakes.

Method

- Relocate water supply intakes to areas that are not influenced by those discharges.

Performance Targets

- Total organic carbon concentrations 3.0 mg/L (quarterly average).
- Bromide concentrations of 50ug/L (quarterly average).
- Turbidity less than or equal to 50 NTU (monthly median).
- Total dissolved solids less than 220 mg/L (10 year average), or less than 440 mg/L (monthly average).
- Protozoa (Giardia, Cryptosporidium oocysts) less than 1 oocyst/100 L (annual average).

Indicators of Success

- Existing modern, well operated treatment plants can successfully and reliably meet current and future drinking water standards without the need to significantly upgrade facilities.
- Absence of waterborne disease outbreaks and quantitative evidence of treatment success by measures such as bacteria counts, pathogen counts, and measurements of organic carbon, disinfection byproducts, and turbidity.

Unknown Toxicity

Action

Identify and implement actions to reduce toxicity to aquatic organisms from chemicals in the water and sediment within the Delta and its tributaries.

Method

- Conducting toxicity testing and toxicity identification evaluations and/or other appropriate methods.
- Coordinate efforts with monitoring programs being conducted by others..

Performance Measure

- Full implementation of a comprehensive toxicity identification and evaluation program.

Indicator of Success

- Successful identifications of causal agents of toxicity in the channels of the Delta estuary and subsequently, a significant reduction (or elimination) of the amount of toxicity present in the rivers and sediments due to successful implementation of control measures for toxicants identified in the CMARP.

Water Management

Action

Reduce the concentration of salinity entering the Delta and its tributaries during low flow periods.

Methods

- Acquiring dilution water from willing sellers.
- Provision of incentives for more efficient water management of dams, including reservoir re-operation.
- Urban water conservation. Conservation might be achieved through use of incentives for implementation of best management practices by more suppliers and water users. Implementation of the action may reduce demand for existing water and may make dilution water available (including transfers), especially on the San Joaquin River
- Greater use of reclaimed wastewater (e.g.,recharge groundwater, treated agricultural drainage, use for agricultural irrigation, recycling and treating for potable or non-potable urban, use of grey water, and storage for use in meeting X2 standards).Reclamation programs would focus on facilities that currently discharge treated wastewater to salt sinks or other degraded bodies of water that are not reusable.
- Enhanced seasonal recharge.
- Development of additional groundwater supplies.

Performance Target

- Reduced salinity loads to the Delta.

Indicator of Success

- Reduced concentrations of total dissolved solids, chloride, and bromide in the San Joaquin River near Vernalis, where the River flows into the Delta.

Action

Reduce salinity for agricultural source water in the South Delta through improved outflow patterns and water circulation in the Delta.

Methods

- Construct one or more tide gates, weirs, dams or sills at the head of Old River and possibly other southern Delta locations to manage drainage flows, tidal currents and stages in the San Joaquin and Middle River and interconnecting channels.
- Relocate Delta island drainage to more efficiently route salinity to the Bay and ocean.
- Provide dilution water for salinity control. (This measure would be considered as one

possible means of mitigating salinity impacts of other CALFED actions, if such mitigation were necessary.)

Performance Measures

- Reduced salinity loads entering southern Delta channels.

Indicator of Success

- Reduced total dissolved solids in the southern reaches of the Old and Middle Rivers.

SECTION 8

WATERSHED COORDINATION

The mission of the CALFED Bay-Delta Program is to develop and implement a long-term comprehensive plan to restore ecological health and improve water management for beneficial uses of the Bay-Delta System. The CALFED Bay-Delta Program is developing and implementing a comprehensive plan to address a declining ecosystem, uncertain water supplies, and imperiled water quality. This plan will include an integrated approach to solving these problems and watershed management is one of the components of that approach. Watershed management will be included in each of the three alternative Bay-Delta solutions as a means of improving water quality, enhancing sources of drinking water, improving ecosystem health and increasing water yield.

As defined in this policy, watershed management is a comprehensive integrated basin-wide approach that may address many of the existing water quality problems as well as the ecosystem restoration needs. For example, water quality problems could include but are not limited to point and non-point sources, ground water and surface water quality degradation. Ecosystem restoration may include fish, wildlife and habitat restoration actions. A watershed-wide focus will help to better integrate and coordinate State/Federal resource management programs with local watershed activities, while ensuring long-term benefits for the Bay-Delta system.

A primary role of CALFED is to coordinate the solution of Bay-Delta system problems on a large scale. CALFED watershed management will be an outgrowth of this role, emphasizing the efforts of diverse interests - environmental, agricultural, industrial, municipal and other local, State and Federal agencies - working together to achieve long term solutions to the problems of the Bay-Delta system.

CALFED fosters local stewardship and supports community based watershed interests. CALFED might, for example, work with local agencies to assist in the formation of alliances and cooperative projects to improve water quality for beneficial uses on a larger scale than might be possible with local agencies working alone or in more narrowly scoped programs.

CALFED supports sound scientific investigations and pilot programs to develop and demonstrate methods for protecting and enhancing beneficial uses of the Bay-Delta System. An important component of CALFED support for programs is to assure development of adequate technical documentation to support decision-making in a long-term adaptive management process. For example, CALFED might assume a leadership role in coordinating assessment activities throughout the watersheds tributary to the Bay-Delta to assure uniform dat collections protocols, uniform application of quality control, standardized analyses, and compatible database structures.

Emphasis for CALFED involvement in watershed management activities will be placed on activities that are consistent with its solution principles to reduce conflict, and to be equitable, affordable, durable, implementable, and not to have significant redirected impacts. Other criteria such as technical, economical, financial, and institutional feasibility will also be considered for any watershed management project.

In all such activities, it will be the CALFED Bay-Delta Program's initial role to assist implementation of projects on a larger watershed scale to help unify individual watershed management activities:

- CALFED may take an active role to help plan and coordinate outreach and educational programs.
- CALFED can serve as a source for information related to watershed-wide activities affecting the Bay-Delta system.
- CALFED will make available funding information by publishing lists of watershed funding sources on a periodic basis.
- CALFED will support and foster local watershed management activities through technical, financial and policy activities.
- CALFED will solicit assistance in developing selection criteria for CALFED funded watershed implementation projects.
- CALFED will develop a Watershed Strategic Plan containing a stakeholder agreed-upon vision for the future of the watershed affecting the Bay-Delta system. This plan will establish water quality, ecosystem restoration, and resource goals.
- CALFED will solicit technical information and will involve the stakeholders and agencies to develop a standardized approach to assure uniform dat collection protocols, application of quality control, standardized analyses, and compatible database structures.
- CALFED can enter into partnerships with entities managing watershed programs.
- CALFED will conduct a survey to assess the number of stakeholder groups who have a vested interest in the benefits of a watershed program. Watershed stakeholders will be actively solicited for their cooperation and CALFED can help to serve as a central network of information to share among the stakeholders.

CALFED watershed management activities will be fully coordinated with existing or new watershed management programs affecting the Bay-Delta System including, but not limited to, the State Water Resources Control Board's Sacramento River Watershed Program, the Sacramento River Toxic Parameter Control Program, and the federal, State and Regional Water Quality Control Board's Watershed Management Initiative Programs.

SECTION 9

REFERENCES

(To Be Added)

APPENDIX A

WATER QUALITY TECHNICAL GROUP STAKEHOLDERS

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James, Mary S.	Sacramento Regional Wastewater Trea	916/875-9120	916/875-9049	
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Jaraczeski, Jeff	Northern California Water Association	916/942-8333	916/942-4035	
Jennings, William	DeltaKeeper	209/464-5090	209/464-5174	
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Jerveson, Ron	San Francisco Bay Regional Water Qu	510/286-1325	510/286-0928	
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Jones, Steven	California Department of Forestry and F	(916) 653-5121		
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Phone Book

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Phone Book

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Phone Book

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Wolfe, Roy	Metropolitan Water District of Southern	213/217-6241	213/217-6951	
Wood, Richard L.	City of Fairfield	707/428-7481		
Woodard, Richard P.	CalFed Bay-Delta Program	916/653-5422	916/653-9745	rwoodard@water.ca.gov
Wyatt, David	CA Dept. of Transportation	(916) 324-6634		
Yaeger, Steve	CalFed Bay-Delta Program	916/657-2666	916/654-9780	
Yamamoto, Gary H.	California Department of Health Service	213/620-2980		
Yardas, David	Environmental Defense Fund	510/658-8008		
Yee, Sue	State of California	(916) 653-5656		
Young, Greg	CalFed Bay-Delta Program	916/657-2666	916/654-9780	gyoung@ch2m.com
Young, Terri	Environmental Defense Fund	510/658-8008	510/658-0630	tfy@edf.org
Zanger, Joe	FSA State Committee			
Ziegler, Sam	U.S. Evnironmental Protection Agency,	415/744-1990	415/744-1078	ziegler.sam@epamail.epa.gov
Zogorski, John S.	U.S. Geological Survey	605/394-1780x21		jszogors@usgs.gov
Zone, Martin	Plumas County Community Developme			
Zuckerman, Tom	Feldman Waldman & Kline			

APPENDIX B

WATER QUALITY AND SEDIMENT DATA SUMMARY TABLES

CALFED
WATER QUALITY DATA SUMMARY
General Parameters

CONSTITUENT	RECEIVING WATER DATA SACRAMENTO	SAN JOAQUIN	DELTA	SF BAY	[illegible]	DISCHARGE WATER QUALITY DATA Stormwater	[illegible]	POTW	AG	Other	Water or Sediment	Time of Study	[illegible]	[illegible]	[illegible]	Author	Date
Alkalinity	X- Greens Landing	X- Vernalis	X- Banks Pumping Plant			X-Natomas East Main Drain			X- Natomas East Main Drain			89-94		Study of Drinking Water Quality in Delta Tributaries	California Urban Water Agencies	Brown & Caldwell Archibald & Wallberg Consultants Marvin Jung & Associates McGuire Environmental Consultants, Inc	1995
Alkalinity		X- Stevenson									water	87-88		Water-Quality Data, San Joaquin Valley, California, April 1987 to September 1988		USGS, Regional Aquifer-System Analysis San Joaquin Valley Drainage Program	
Dissolved Oxygen	X- Freeport, Rio Vista	X-Stockton, Vernalis, Manteca		X-North, South, Central							water	1993		1993 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1993
Dissolved Oxygen	X- Freeport, Rio Vista	X-Stockton, Vernalis, Manteca		X-North, South, Central							water	1994		1994 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1994
Dissolved Oxygen	X	X		X-North, South, Central							water	1995		1995 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1995
Dissolved Oxygen	X- Veterans Bridge, Freeport Marina, River Mile 44										water	94-95		Sacramento Coordinated Water Quality Monitoring Program 1995 Annual Report	Sacramento Regional County Sanitation District Sacramento County Water Agency City of Sacramento	Larry Walker Associates	Feb-96
Dissolved Oxygen		X- Stevenson									water	87-88		Water-Quality Data, San Joaquin Valley, California, April 1987 to September 1988		USGS, Regional Aquifer-System Analysis San Joaquin Valley Drainage Program	
Dissolved Oxygen		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis			X- Multiple					X- TID #5 (dairy discharge)	water	91		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; March and April 1991		Lisa Ross	Nov-91
Dissolved Oxygen		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis, Maze Blvd.			X- Multiple					X- TID #5 (dairy discharge)	water	91-92		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; Winter 1991-2		Lisa Ross	May-92

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WATER QUALITY DATA SUMMARY
General Parameters

CONSTITUENT	RECEIVING WATER DATA SACRAMENTO	SAN JOAQUIN	DELTA	SF BAY	Discharge Water Quality Data Creeks	Stormwater	Rain/Fog	POTW	AG	Other	Water/Sediment	Time of Study	Notes	Report	Prepared For	Author	Date
Dissolved Oxygen		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis, Maze Blvd.			X- Multiple					X- TID #5 (dairy discharge)	water	92		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; Spring 1992		Lisa Ross	Apr-93
Dissolved Oxygen		X- Laird Park, Airport Way, Hills Ferry,			X- Orestimba Creek, Los Banos Creek, Ingram Hospital, Merced River, Del Puerto Creek, Tuolumne River, Stanislaus River				X- TID 3,5,6 , Spanish Grant Drain		water	91-92		CRWQCB Insecticide Concentrations and Invertebrate Bioassay Mortality in Agricultural Return Water from the San Joaquin Basin		Christopher Foe, CRWQCB	Dec-95
Dissolved Oxygen		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis, Maze Blvd.			X- Multiple					X- TID #5 (dairy discharge)	water	92		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; Summer 1992		Lisa Ross	Sep-93
Dissolved Oxygen		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis, Maze Blvd.			X- Multiple					X- TID #5 (dairy discharge)	water	92-93		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; Winter 1992-3		Lisa Ross	Sep-93
Dissolved Oxygen		X				X-AG						88-90	bioassay, drought years	Insecticide Concentrations and Invertebrate Bioassay Mortality in Agricultural Return Water from San Joaquin Basin		Central Valley RWQCB	1995
Dissolved Oxygen	X-Greens landing	X- Vernalis	X-Mendota Canal others						drainage	pumping plant sloughs	water	82-91		Appendix C1- Analysis of Delta Inflow and Export Water Quality Data	Delta Wetlands Project??	Jones & Stokes Associates??	Sep-95
Dissolved Oxygen			X-Multiple						X		soil	67-91		AppendixC4: Delta drainage water Quality Model	Delta Wetlands Project??	Jones & Stokes Associates??	Sep-95
Dissolved Oxygen	X				X						water			Sacramento Coordinated Water Quality Monitoring Program 1995 annual report	Sacramento Regional County Sanitation District Sac. County water Agency City of Sac	Larry Walker Associates	1996
Dissolved Oxygen	X- Multiple	X- Multiple	X	X- San Pablo Bay								75-93	Available via internet www.iep.ca.gov	Interagency Ecological Program for the Sacramento San Joaquin Delta. Water Quality Monitoring Database METAFILE.DOC			
DOC/TOC	X- Veterans Bridge, Freeport Marina, River Mile 44										water	94-95		Sacramento Coordinated Water Quality Monitoring Program 1995 Annual Report	Sacramento Regional County Sanitation District Sacramento County Water Agency City of Sacramento	Larry Walker Associates	Feb-96

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WATER QUALITY DATA SUMMARY
General Parameters

CONSTITUENT	RECEIVING WATER DATA SACRAMENTO	SAN JOAQUIN	DELTA	S.F. BAY	Discharge Water Quality Data Creeks	Stormwater	Rain/Fog	POTW	AG	Other	Water/ Sediment	Time of Study	Notes	Report	Prepared For	Author	Date
Hardness	X- Freeport, Rio Vista	X-Stockton, Vernalis, Manteca		X-North, South, Central							water	1994		1994 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1994
Hardness	X	X		X-North, South, Central							water	1995		1995 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1995
Hardness	X- Veterans Bridge, Freeport Marina, River Mile 44										water	94-95		Sacramento Coordinated Water Quality Monitoring Program 1995 Annual Report	Sacramento Regional County Sanitation District Sacramento County Water Agency City of Sacramento	Larry Walker Associates	Feb-96
Hardness		X- Stevenson									water	87-88		Water-Quality Data, San Joaquin Valley, California, April 1987 to September 1988		USGS, Regional Aquifer-System Analysis San Joaquin Valley Drainage Program	
Hardness						X- 5 locations representing residential, commercial and industrial land uses					water	10/92 -2/93		Municipal Storm Water Discharge Management Program Technical Memorandum Task 3.1 Storm Water Characterization Study	Camp, Dresser & McKee, Inc.	Kinetic Laboratories, Inc.	Jan-94
Hardness					X- Receiving waters below Sacramento Valley mines						water	86-90		CRWQCB, Central Valley Region Standards, Policies, and Special Studies Unit, Inactive Mine Drainage in the Sacramento Valley, California		Barry Montoya, Xiamang Pan	Jul-92
Hardness					X- Rheem Creek (San Pablo Bay), Walnut Creek (Suisun Bay)						water	94-95		Contra Costa Clean Water Program FY 1994-1995 Monitoring Report		Woodward-Clyde Consultants	Sep-95
Hardness					X- Rheem Creek (San Pablo Bay), Walnut Creek (Suisun Bay)						water	94-95		Contra Costa Clean Water Program FY 1995-1996 Monitoring Report		Woodward-Clyde Consultants	96
pH	X- Freeport, Rio Vista	X-Stockton, Vernalis, Manteca		X-North, South, Central							water, sediment	1993		1993 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1993
pH	X- Freeport, Rio Vista	X-Stockton, Vernalis, Manteca		X-North, South, Central							water, sediment	1994		1994 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1994

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WATER QUALITY DATA SUMMARY
General Parameters

CONSTITUENT	RECEIVING WATER DATA SACRAMENTO	SAN JOAQUIN	DELTA	SF BAY	Creeks	Discharge Water Quality Data Stormwater	Rain/Fog	POTW	AG	Other	Water/Sediment	Time of Study	Notes	Report	Prepared For	Author	Date
pH	X	X		X-North, South, Central							water, sediment	1995		1995 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1995
pH	X- Veterans Bridge, Freeport Marina, River Mile 44										water	1994-1995		Sacramento Coordinated Water Quality Monitoring Program 1995 Annual Report	Sacramento Regional County Sanitation District Sacramento County Water Agency City of Sacramento	Larry Walker Associates	Feb-96
pH					X-Spring Creek, Keswick Reservoir, Keswick Dam (Sacramento)						water	1979-1980		Evaluation of Lethal Levels, Release Criteria, and Water Quality Objectives for an Acid Mine Waste in *Aquatic Toxicology and Environmental Fate: Eleventh Volume*, ASTM STP 1007, pp. 189-203		Brian J. Finlayson, Dennis C. Wilson	1989
pH		X- Stevenson									water	1987-1988		Water-Quality Data, San Joaquin Valley, California, April 1987 to September 1988		USGS, Regional Aquifer-System Analysis San Joaquin Valley Drainage Program	
pH		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis			X- Multiple					X- TID #5 (dairy discharge)	water	91		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; March and April 1991		Lisa Ross	Nov-91
pH		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis, Maze Blvd.			X- Multiple					X- TID #5 (dairy discharge)	water	91-92		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; Winter 1991-2		Lisa Ross	May-92
pH		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis, Maze Blvd.			X- Multiple					X- TID #5 (dairy discharge)	water	92		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; Spring 1992		Lisa Ross	Apr-93
pH						X- 5 locations representing residential, commercial and industrial land uses					water	10/92-2/93		Municipal Storm Water Discharge Management Program Technical Memorandum Task 3.1 Storm Water Characterization Study	Camp, Dresser & McKee, Inc.	Kinetic Laboratories, Inc.	Jan-94

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WATER QUALITY DATA SUMMARY
General Parameters

CONSTITUENT	RECEIVING WATER DATA: SACRAMENTO	SAN JOAQUIN	DELTA	SF BAY	Discharge Water Quality Data: Creeks	Stormwater	Rain/Fog	POTW	AG	Other	Water/Sediment	Time of Study	NOTES	TITLE	FUNDING ORG.	AUTHOR	DATE
pH					X- Receiving waters below Sacramento Valley mines					X- Mine Drainage, Shasta Dam	water	86-90	Also list waste rock pH, and acid generating potential	CRWQCB, Central Valley Region Standards, Policies, and Special Studies Unit, Inactive Mine Drainage in the Sacramento Valley, California		Barry Montoya, Xiamang Pan	Jul-92
pH					X- Rheem Creek (San Pablo Bay), Walnut Creek (Suisun Bay)						water	94-95		Contra Costa Clean Water Program FY 1995-1996 Monitoring Report		Woodward-Clyde Consultants	96
pH		X- Laird Park, Airport Way, Hills Ferry,			X- Orestimba Creek, Los Banos Creek, Ingram Hospital, Merced River, Del Puerto Creek, Tuolumne River, Stanislaus River				X- TID 3,5,6 , Spanish Grant Drain		water	91-92		CRWQCB Insecticide Concentrations and Invertebrate Bioassay Mortality in Agricultural Return Water from the San Joaquin Basin		Christopher Foe, CRWQCB	Dec-95
pH		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis, Maze Blvd.			X-Multiple					X- TID #5 (dairy discharge)	water	92		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; Summer 1992		Lisa Ross	Sep-93
pH		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis, Maze Blvd.			X-Multiple					X- TID #5 (dairy discharge)	water	92-93		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; Winter 1992-3		Lisa Ross	Sep-93
pH	X				X						water			Sacramento Coordinated Water Quality Monitoring Program 1995 annual report	Sacramento Regional County Sanitation District Sac. County water Agency City of Sac	Larry Walker Associates	1996
pH (alkalinity)	X-									mines	water		Effects on fish	Evaluation of Lethal Levels, release Criteria, and Water Quality Objectives for an Acid-Mine Waste		B.J. Finlayson D. C. Wilson	1989
pH	X- Multiple	X- Multiple	X	X- San Pablo Bay								75-93	Available via internet www.iep.ca.gov	Interagency Ecological Program for the Sacramento San Joaquin Delta. Water Quality Monitoring Database METAFILE.DOC			
Temperature	X- Freeport, Rio Vista	X-Stockton, Vernalis, Manteca		X-North, South, Central							water, sediment	1993		1993 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1993
Temperature	X- Freeport, Rio Vista	X-Stockton, Vernalis, Manteca		X-North, South, Central							water, sediment	1994		1994 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1994

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WATER QUALITY DATA SUMMARY
General Parameters

CONSTITUENT	RECEIVING WATER DATA				Discharge Water Quality Data						Water/Sediment	Time of Study	[illegible]	Report	[illegible]	Author	Date
	SACRAMENTO	SAN JOAQUIN	DELTA	SF BAY	[illegible]	Stormwater	Rain/Fog	POTW	AG	Other							
Temperature	X	X		X-North, South, Central							water	1995		1995 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1995
Temperature	X- Veterans Bridge, Freeport Marina, River Mile 44										water	1994-1995		Sacramento Coordinated Water Quality Monitoring Program 1995 Annual Report	Sacramento Regional County Sanitation District Sacramento County Water Agency City of Sacramento	Larry Walker Associates	Feb-96
Temperature		X- Stevenson									water	1987-1988		Water-Quality Data, San Joaquin Valley, California, April 1987 to September 1988		USGS, Regional Aquifer-System Analysis San Joaquin Valley Drainage Program	
Temperature		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis			X- Multiple					X- TID #5 (dairy discharge)	water	91		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; March and April 1991		Lisa Ross	Nov-91
Temperature		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis, Maze Blvd.			X- Multiple					X- TID #5 (dairy discharge)	water	91-92		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; Winter 1991-2		Lisa Ross	May-92
Temperature		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis, Maze Blvd.			X- Multiple					X- TID #5 (dairy discharge)	water	92		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; Spring 1992		Lisa Ross	Apr-93
Temperature		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis, Maze Blvd.			X- Multiple					X- TID #5 (dairy discharge)	water	92		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; Summer 1992		Lisa Ross	Sep-93
Temperature		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis, Maze Blvd.			X- Multiple					X- TID #5 (dairy discharge)	water	92-93		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; Winter 1992-3		Lisa Ross	Sep-93
Temperature	X				X						water			Sacramento Coordinated Water Quality Monitoring Program 1995 annual report	Sacramento Regional County Sanitation District Sac. County water Agency City of Sac	Larry Walker Associates	1996

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WATER QUALITY DATA SUMMARY
General Parameters

CONSTITUENT	RECEIVING WATER DATA				Discharge Water Quality Data						Water or Sediment	Time of Study	Notes	Report	Prepared For	Author	Date
	SACRAMENTO	SAN JOAQUIN	DELTA	SF BAY	Creeks	Stormwater	Rain/Fog	POTW	AG	Other							
Temperature	X- Multiple	X- Multiple	X	X- San Pablo Bay								75-93	Available via internet www.iep.ca.gov	Interagency Ecological Program for the Sacramento San Joaquin Delta. Water Quality Monitoring Database METAFILE.DOC			
TOC		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis			X- Multiple					X- TID #5 (dairy discharge)	water	91		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; March and April 1991		Lisa Ross	Nov-91
TOC		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis, Maze Blvd.			X- Multiple					X- TID #5 (dairy discharge)	water	91-92		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; Winter 1991-2		Lisa Ross	May-92
TOC		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis, Maze Blvd.			X- Multiple					X- TID #5 (dairy discharge)	water	92		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; Spring 1992		Lisa Ross	Apr-93
TOC						X- 5 locations representing residential, commercial and industrial land uses					water	10/92-2/93		Municipal Storm Water Discharge Management Program Technical Memorandum Task 3.1 Storm Water Characterization Study	Camp, Dresser & McKee, Inc.	Kinetic Laboratories, Inc.	Jan-94
TOC					X- Rheem Creek (San Pablo Bay), Walnut Creek (Suisun Bay)						water	94-95		Contra Costa Clean Water Program FY 1995-1996 Monitoring Report		Woodward-Clyde Consultants	96
TOC		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis, Maze Blvd.			X- Multiple					X- TID #5 (dairy discharge)	water	92		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; Summer 1992		Lisa Ross	Sep-93
TOC		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis, Maze Blvd.			X- Multiple					X- TID #5 (dairy discharge)	water	92-93		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; Winter 1992-3		Lisa Ross	Sep-93
TOC	X				X						water			Sacramento Coordinated Water Quality Monitoring Program 1995 annual report	Sacramento Regional County Sanitation District Sac. County water Agency City of Sac	Larry Walker Associates	1996

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WATER QUALITY DATA SUMMARY
General Parameters

CONSTITUENT	RECEIVING WATER DATA SACRAMENTO	SAN JOAQUIN	DELTA	SF BAY	Creeks	Discharge Water Quality Data Stormwater	Rain/Fog	POTW	AG	Other	Water/ Sediment	Time of Study	Notes	Report	Funded By	Author	Date
TOC/DOC	X- Greens Landing	X- Vernalis	X- Banks Pumping Plant			X-Natomas East Main Drain		X- Sacramento Regional Wastewater Effluent	X- Natomas East Main Drain		water	90-93		Study of Drinking Water Quality in Delta Tributaries	California Urban Water Agencies	Brown & Caldwell Archibald & Wallberg Consultants Marvin Jung & Associates McGuire Environmental Consultants, Inc	1995
TOC/DOC	X- Freeport, Rio Vista	X-Stockton, Vernalis, Manteca		X-North, South, Central							water, sediment	1994	DOC for water; TOC for sediment	1994 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1994
TOC/DOC	X	X		X-North, South, Central							water, sediment	1995	DOC for water; TOC for sediment	1995 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1995
Toxicity	X- Freeport, Rio Vista	X-Stockton, Vernalis, Manteca		X-North, South, Central							water, sediment	1993	48-hour mollusk embryo development; 96-hr. algal growth	1993 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1993
Toxicity	X- Rio Vista	X- Manteca		X-North, South, Central							water, sediment	1994		1994 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1994
Toxicity	X	X		X-North, South, Central							water, sediment	1995		1995 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1995
Toxicity					X-Spring Creek, Keswick Reservoir, Keswick Dam (Sacramento)						water	79-80	Chinook salmon, steelhead trout	Evaluation of Lethal Levels, Release Criteria, and Water Quality Objectives for an Acid Mine Waste in *Aquatic Toxicology and Environmental Fate: Eleventh Volume*, ASTM STP 1007, pp. 189-203		Brian J. Finlayson, Dennis C. Wilson	1989
Toxicity					X- Rheem Creek (San Pablo Bay), Walnut Creek (Suisun Bay)						water	94-95	*Ceriodaphnia*	Contra Costa Clean Water Program FY 1995-1996 Monitoring Report		Woodward-Clyde Consultants	96
Toxicity	X		X- Freeport, Clarksburg, Walnut Grove, Isleton, Steamboat Slough		X- Sacramento Basin, San Joaquin Basin	X- Sacramento, Stockton			X- Colusa Basin Drain, TID # 3,5,6		water	86-92	Fathead Minnow, *Ceriodaphnia, Selenastrum, Neomysis*, Striped Bass Toxicity	Aquatic Toxicity and Pesticides in Surface Waters of the Central Valley	California Urban Water Agencies	J. Phyllis Fox, Elaine Archibald	Jul-96

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CALFED
WATER QUALITY DATA SUMMARY
General Parameters

CONSTITUENT	RECEIVING WATER DATA: SACRAMENTO	SAN JOAQUIN	DELTA	SF BAY	[illegible]: Creeks	Stormwater	[illegible]	POTW	AG	Other	Water/ Sediment	Time of Study	Notes	Report	[illegible]	Author	Date
Toxicity		X- Airport Way, Hills Ferry, Laird Park			X- Orestimba Creek, Ingram Hospital, Merced River, Del Puerto Creek, Tuolumne River, Stanislaus River				X- TID 3,5,6, Salt Slough, Spanish Grant Drain		water	91-92	*Ceriodaphnia*	CRWQCB Insecticide Concentrations and Invertebrate Bioassay Mortality in Agricultural Return Water from the San Joaquin Basin		Christopher Foe, CRWQCB	Dec-95
Toxicity		X- Airport Way, Hills Ferry			X- Orestimba Creek, Ingram Hospital, Merced River, Del Puerto Creek, Tuolumne River		EC		X- TID 3,5,6, Salt Slough, Spanish Grant Drain		water	91-92		CRWQCB Insecticide Concentrations and Invertebrate Bioassay Mortality in Agricultural Return Water from the San Joaquin Basin		Christopher Foe, CRWQCB	Dec-95
TSS	X- Freeport, Rio Vista	X-Stockton, Vernalis, Manteca		X-North, South, Central							water	1993		1993 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1993
TSS	X- Freeport, Rio Vista	X-Stockton, Vernalis, Manteca		X-North, South, Central							water	1994		1994 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1994
TSS	X	X		X-North, South, Central							water	1995		1995 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1995
TSS	X- Veterans Bridge, Freeport Marina, River Mile 44										water	94-95		Sacramento Coordinated Water Quality Monitoring Program 1995 Annual Report	Sacramento Regional County Sanitation District Sacramento County	Larry Walker Associates	Feb-96
TSS		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis			X- Multiple					X- TID #5 (dairy discharge)	water	91		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; March and April 1991		Lisa Ross	Nov-91
TSS		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis, Maze Blvd.			X- Multiple					X- TID #5 (dairy discharge)	water	91-92		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; Winter 1991-2		Lisa Ross	May-92
TSS		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis, Maze Blvd.			X- Multiple					X- TID #5 (dairy discharge)	water	92		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; Spring 1992		Lisa Ross	Apr-93

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WATER QUALITY DATA SUMMARY
General Parameters

CONSTITUENT	RECEIVING WATER DATA				Discharge Water Quality Data						Water or Sediment	Time of Study	Notes	Report	Sponsored By	Author	Date
	SACRAMENTO	SAN JOAQUIN	DELTA	SF BAY	Creeks	Stormwater	Rain/Fog	POTW	AG	Other							
TSS						X- 5 locations representing residential, commercial and industrial land uses					water	10/92-2/93		Municipal Storm Water Discharge Management Program Technical Memorandum Task 3.1 Storm Water Characterization Study	Camp, Dresser & McKee, Inc.	Kinetic Laboratories, Inc.	Jan-94
TSS					X- Rheem Creek (San Pablo Bay), Walnut Creek (Suisun Bay)						water	94-95		Contra Costa Clean Water Program FY 1995-1996 Monitoring Report		Woodward-Clyde Consultants	96
TSS		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis, Maze Blvd.			X- Multiple					X- TID #5 (dairy discharge)	water	92		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; Summer 1992		Lisa Ross	Sep-93
TSS		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis, Maze Blvd.			X- Multiple					X- TID #5 (dairy discharge)	water	92-93		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; Winter 1992-3		Lisa Ross	Sep-93
TSS	X- Multiple	X- Multiple	X	X- San Pablo Bay								75-93	Available via internet www.iep.ca.gov	Interagency Ecological Program for the Sacramento San Joaquin Delta. Water Quality Monitoring Database METAFILE.DOC			
Turbidity					X- Rheem Creek (San Pablo Bay), Walnut Creek (Suisun Bay)						water	94-95		Contra Costa Clean Water Program FY 1995-1996 Monitoring Report		Woodward-Clyde Consultants	96
Turbidity	X- Multiple	X- Multiple	X	X- San Pablo Bay								75-93	Available via internet www.iep.ca.gov	Interagency Ecological Program for the Sacramento San Joaquin Delta. Water Quality Monitoring Database METAFILE.DOC			
Turbidity	X-Greens landing	X- Vernalis	X-Mendota Canal others						drainage	pumping plant sloughs	water	82-91		Appendix C1- Analysis of Delta Inflow and Export Water Quality Data	Delta Wetlands Project??	Jones & Stokes Associates??	Sep-95

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WATER QUALITY DATA SUMMARY
Nutrients

CONSTITUENT	RECEIVING WATER DATA SACRAMENTO	SAN JOAQUIN	DELTA	SF BAY	Discharge Water Quality Data Creeks	Stormwater	Rain/Fog	POTW	AG	Other	Water or Sediment	Time of Study	Notes	Report	Prepared For	Author	Date
Ammonia	X- Greens Landing		X- Banks Pumping Plant					X- Sacramento Regional Wastewater Treatment Plant			water	83-91		Study of Drinking Water Quality in Delta Tributaries	California Urban Water Agencies	Brown & Caldwell Archibald & Wallberg Consultants Marvin Jung & Associates McGuire Environmental Consultants, Inc	1995
Ammonia	X- Freeport, Rio Vista	X-Stockton, Vernalis, Manteca		X-North, South, Central							water	1993		1993 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1993
Ammonia	X- Freeport, Rio Vista	X-Stockton, Vernalis, Manteca		X-North, South, Central							water	1994		1994 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1994
Ammonia	X	X		X-North, South, Central							water, sediment	1995		1995 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1995
Ammonia		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis			X- Multiple					X- TID #5 (dairy discharge)	water	91		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; March and April 1991		Lisa Ross	Nov-91
Ammonia		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis, Maze Blvd.			X- multiple					X- TID #5 (dairy discharge)	water	91-92		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; Winter 1991-2		Lisa Ross	May-92
Ammonia		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis, Maze Blvd.			X- Multiple					X- TID #5 (dairy discharge)	water	92		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; Spring 1992		Lisa Ross	Apr-93
Ammonia						X- 5 locations representing residential, commercial and industrial land uses					water	10/92-2/93		Municipal Storm Water Discharge Management Program Technical Memorandum Task 3.1 Storm Water Characterization Study	Camp, Dresser & McKee, Inc.	Kinetic Laboratories, Inc.	Jan-94
Ammonia		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis, Maze Blvd.			X- Multiple					X- TID #5 (dairy discharge)	water	92		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; Summer 1992		Lisa Ross	Sep-93

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WATER QUALITY DATA SUMMARY
Nutrients

CONSTITUENT	RECEIVING WATER DATA SACRAMENTO	SAN JOAQUIN	DELTA	SF BAY	Creeks	Discharge Water Quality Data Stormwater	Rain/Fog	POTW	AG	Other	Water or Sediment	Time of Study	Notes	Report	Prepared For	Author	Date
Ammonia		X- Laird Park, Airport Way, Hills Ferry,			X- Multiple				X- TID 3,5,6 , Spanish Grant Drain	Un-ionized	water	91-92		CRWQCB Insecticide Concentrations and Invertebrate Bioassay Mortality in Agricultural Return Water from the San Joaquin Basin		Christopher Foe, CRWQCB	Dec-95
Ammonia		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis, Maze Blvd.			X- Multiple					X- TID #5 (dairy discharge)	water	92-93		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; Winter 1992-3		Lisa Ross	Sep-93
Ammonia		X				X-AG						88-90	bioassay, drought years	Insecticide Concentrations and Invertebrate Bioassay Mortality in Agricultural Return Water from San Joaquin Basin		Central Valley RWQCB	1995
Ammonia	X- Multiple	X- Multiple	X	X- San Pablo Bay								75-93	Available via Internet www.iep.ca.gov	Interagency Ecological Program for the Sacramento San Joaquin Delta. Water Quality Monitoring Database			
Nitrate						X- 5 locations representing residential, commercial and industrial land uses					water	10/92-2/93		Municipal Storm Water Discharge Management Program Technical Memorandum Task 3.1 Storm Water Characterization Study	Camp, Dresser & McKee, Inc.	Kinetic Laboratories, Inc.	Jan-94
Nitrate/Nitrite	X- Freeport		X- Banks Pumping Plant					X- Sacramento Regional Wastewater Treatment Plant			water	90-93		Study of Drinking Water Quality in Delta Tributaries	California Urban Water Agencies	Brown & Caldwell Archibald & Wallberg Consultants Marvin Jung & Associates McGuire Environmental Consultants, Inc	1995
Nitrate/Nitrite	X- Freeport, Rio Vista	X-Stockton, Vernalis, Manteca		X-North, South, Central							water	1994		1994 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1994
Nitrate/Nitrite	X	X		X-North, South, Central							water	1995		1995 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1995
Nitrate/Nitrite, Nitrogen	X- Freeport, Rio Vista	X-Stockton, Vernalis, Manteca		X-North, South, Central							water, sediment	1993	Total N for sediment	1993 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1993

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WATER QUALITY DATA SUMMARY
Nutrients

CONSTITUENT	RECEIVING WATER DATA SACRAMENTO	SAN JOAQUIN	DELTA	SF BAY	Creeks	Discharge Water Quality Data Stormwater	Rain/Fog	POTW	AG	Other	Water or Sediment	Time of Study	Notes	Paper Title	Prepared For	Author	Date
Nitrate/ Nitrite, Organic N	X- Multiple	X- Multiple	X	X- San Pablo Bay								75-93	Available via internet www.iep.ca.gov	Interagency Ecological Program for the Sacramento San Joaquin Delta. Water Quality Monitoring Database			
Phosphate	X- Freeport, Rio Vista	X-Stockton, Vernalis, Manteca		X-North, South, Central							water	1993		1993 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1993
Phosphate	X- Freeport, Rio Vista	X-Stockton, Vernalis, Manteca		X-North, South, Central							water	1994		1994 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1994
Phosphate	X	X		X-North, South, Central							water	1995		1995 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1995
Phosphorus						X- 5 locations representing residential, commercial and industrial land uses					water	10/92-2/93	Total, dissolved	Municipal Storm Water Discharge Management Program Technical Memorandum Task 3.1 Storm Water Characterization Study	Camp, Dresser & McKee, Inc.	Kinetic Laboratories, Inc.	Jan-94
Total P	X- Freeport		X- Banks Pumping Plant					X- Sacramento Regional Wastewater Treatment Plant			water	89-93		Study of Drinking Water Quality in Delta Tributaries	California Urban Water Agencies	Brown & Caldwell Archibald & Wallberg Consultants Marvin Jung & Associates McGuire Environmental Consultants, Inc	1995
Phosphorus	X- Multiple	X- Multiple	X	X- San Pablo Bay								75-93	Available via internet www.iep.ca.gov	Interagency Ecological Program for the Sacramento San Joaquin Delta. Water Quality Monitoring Database METAFILE.DOC			
TKN	X- Multiple	X- Multiple	X	X- San Pablo Bay								75-93	Available via internet www.iep.ca.gov	Interagency Ecological Program for the Sacramento San Joaquin Delta. Water Quality Monitoring Database			
TKN						X- 5 locations representing residential, commercial and industrial land uses					water	10/92-2/93		Municipal Storm Water Discharge Management Program Technical Memorandum Task 3.1 Storm Water Characterization Study	Camp, Dresser & McKee, Inc.	Kinetic Laboratories, Inc.	Jan-94

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WATER QUALITY DATA SUMMARY
Salts

CONSTITUENT	RECEIVING WATER DATA					Discharge Water Quality Data					Water/	Time	[illegible]	Report	Prepared	Author	Date
	SACRAMENTO	SAN JOAQUIN	DELTA	SF BAY	Creeks	Stormwaters	Rain/Fog	POTW	AG	Other	Sediment	of Study	[illegible]	[illegible]	for	[illegible]	[illegible]
Bromide	X- Greens Landing	X- Vernalis	X- Banks Pumping Plant			X-Natomas East Main Drain			X-Natomas East Main Drain		water	90-94		Study of Drinking Water Quality in Delta Tributaries	California Urban Water Agencies	Brown & Caldwell Archibald & Wallberg Consultants Marvin Jung & Associates McGuire Environmental Consultants, Inc	1995
Bromide	X-Greene's landing	X- Vernalis	X- Mendola Canal others						drainage	pumping plant sloughs	water	82-91		Appendix C1- Analysis of Delta Inflow and Export Water Quality Data	Delta Wetlands Project??	Jones & Stokes Associates??	Sep-95
Bromide	X-Greene's landing	X- Vernalis	X- Mendola Canal others						drainage	pumping plant sloughs	water	82-91		Appendix C1- Analysis of Delta Inflow and Export Water Quality Data	Delta Wetlands Project??	Jones & Stokes Associates??	Sep-95
Chloride		X- Stevenson									water	87-88		Water-Quality Data, San Joaquin Valley, California, April 1987 to September 1988		USGS, Regional Aquifer-System Analysis San Joaquin Valley Drainage Program	
Chloride	X-Greene's landing	X- Vernalis	X- Mendola Canal others						drainage	pumping plant sloughs	water	82-91		Appendix C1- Analysis of Delta Inflow and Export Water Quality Data	Delta Wetlands Project??	Jones & Stokes Associates??	Sep-95
Chloride	X- Multiple	X- Multiple	X	X- San Pablo Bay								75-93	Available via internet www.iep.ca.gov	Interagency Ecological Program for the Sacramento San Joaquin Delta. Water Quality Monitoring Database METAFILE.DOC			
EC	X- Freeport, Rio Vista	X-Stockton, Vernalis, Manteca		X-North, South, Central							water	1994		1994 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1994
EC	X	X		X-North, South, Central							water	1995		1995 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1995
EC	X- Veterans Bridge, Freeport Marina, River Mile 44										water	94-95		Sacramento Coordinated Water Quality Monitoring Program 1995 Annual Report	Sacramento Regional County Sanitation District Sacramento County Water Agency City of Sacramento	Larry Walker Associates	Feb-96

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WATER QUALITY DATA SUMMARY
Salts

CONSTITUENT	RECEIVING WATER DATA				Discharge Water Quality Data						Water or	Time	Notes	Paper	Prepared	Author	Date
	SACRAMENTO	SAN JOAQUIN	DELTA	SF BAY	Creeks	Stormwater	Rain/Fog	POTW	AG	Other	Sediment	of Study			For		
EC					X-Spring Creek, Keswick Reservoir, Keswick Dam (Sacramento)						water	79-80		Evaluation of Lethal Levels, Release Criteria, and Water Quality Objectives for an Acid Mine Waste in *Aquatic Toxicology and Environmental Fate: Eleventh Volume*, ASTM STP 1007, pp. 189-203		Brian J. Finlayson, Dennis C. Wilson	1989
EC		X- Stevenson									water	87-88		Water-Quality Data, San Joaquin Valley, California, April 1987 to September 1988		USGS, Regional Aquifer-System Analysis San Joaquin Valley Drainage Program	
EC		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis			X- Multiple					X- TID #5 (dairy discharge)	water	91		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; March and April 1991		Lisa Ross	Nov-91
EC		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis, Maze Blvd.			X- Multiple					X- TID #5 (dairy discharge)	water	91-92		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; Winter 1991-2		Lisa Ross	May-92
EC		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis, Maze Blvd.			X- Multiple					X- TID #5 (dairy discharge)	water	92		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; Spring 1992		Lisa Ross	Apr-93
EC						X- 5 locations representing residential, commercial and industrial land uses					water	10/92-2/93		Municipal Storm Water Discharge Management Program Technical Memorandum Task 3.1 Storm Water Characterization Study	Camp, Dresser & McKee, Inc.	Kinetic Laboratories, Inc.	Jan-94
EC					X- Receiving waters below Sacramento Valley mines					X- Mine Drainage, Shasta Dam	water	86-90	Also list waste rock pH, and acid generating potential	CRWQCB, Central Valley Region Standards, Policies, and Special Studies Unit, Inactive Mine Drainage in the Sacramento Valley, California		Barry Montoya, Xiamang Pan	Jul-92
EC		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis, Maze Blvd.			X- Multiple					X- TID #5 (dairy discharge)	water	92		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; Summer 1992		Lisa Ross	Sep-93

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WATER QUALITY DATA SUMMARY
Salts

CONSTITUENT	RECEIVING WATER DATA: SACRAMENTO	SAN JOAQUIN	DELTA	SF BAY	Discharge Water Quality Data: Creeks	Stormwater	Rain/Fog	POTW	AG	Other	Water or Sediment	Time of Study	Notes	Paper	Prepared For	Author	Date
EC		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis, Maze Blvd.			X- Multiple					X- TID #5 (dairy discharge)	water	92-93		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; Winter 1992-3		Lisa Ross	Sep-93
EC	X- Freeport, Rio Vista	X-Stockton, Vernalis, Manteca		X-North, South, Central							water	1993		1993 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1993
EC	X- Multiple	X- Multiple	X	X- San Pablo Bay								75-93	Available via internet www.iep.ca.gov	Interagency Ecological Program for the Sacramento San Joaquin Delta. Water Quality Monitoring Database METAFILE.DOC			
Salinity	X- Freeport, Rio Vista	X-Stockton, Vernalis, Manteca		X-North, South, Central							water	1993		1993 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1993
Salinity	X- Freeport, Rio Vista	X-Stockton, Vernalis, Manteca		X-North, South, Central							water	1994		1994 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1994
Salinity	X	X		X-North, South, Central							water	1995		1995 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1995
Salinity (TDS, EC)		X-Vernalis, multiple										85-87	low/high flow, mud and salt sloughs	Sources and Concentrations of Selenium in the San Joaquin River		USGS/Saphen Clifton, Robert Gilliom	1988
Salinity (TDS, EC)		X				X-AG						88-90	bioassay, drought years	Insecticide Concentrations and Invertebrate Bioassay Mortality in Agricultural Return Water from San Joaquin Basin		Central Valley RWQCB	1995
Salinity (TDS, EC)	X-Greene's landing	X- Vernalis	X- Mendola Canal others						drainage	pumping plant sloughs	water	82-91		Appendix C1- Analysis of Delta Inflow and Export Water Quality Data	Delta Wetlands Project??	Jones & Stokes Associates??	Sep-95
Salinity (TDS, EC)			X-Multiple						X			1955, 86-92		Appendix C2:Analysis of Delta Agricultural Drainage Water Quality Data	Delta Wetlands Project??	Jones & Stokes Associates??	Sep-95
Salinity (TDS, EC)			X-Multiple						X		soil	67-91		AppendixC4: Delta drainage water Quality Model	Delta Wetlands Project??	Jones & Stokes Associates??	Sep-95

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WATER QUALITY DATA SUMMARY
Salts

CONSTITUENT	RECEIVING WATER DATA				Discharge Water Quality Data						Water or Sediment	Time of Study	Notes	Paper	Prepared For	Author	Date
	SACRAMENTO	SAN JOAQUIN	DELTA	SF BAY	Creeks	Stormwater	Rain/Fog	POTW	AG	Other							
TDS		X- Stevenson									water	87-88		Water-Quality Data, San Joaquin Valley, California, April 1987 to September 1988		USGS, Regional Aquifer-System Analysis San Joaquin Valley Drainage Program	
TDS						X- 5 locations representing residential, commercial and industrial land uses					water	10/92-2/93		Municipal Storm Water Discharge Management Program Technical Memorandum Task 3.1 Storm Water Characterization Study	Camp, Dresser & McKee, Inc.	Kinetic Laboratories, Inc.	Jan-94
TDS	X- Multiple	X- Multiple	X	X- San Pablo Bay								75-93	Available via internet www.iep.ca.gov	Interagency Ecological Program for the Sacramento San Joaquin Delta. Water Quality Monitoring Database METAFILE.DOC			
TDS/EC	X- Greens Landing	X- Vernalis	X- Banks Pumping Plant			X-Natomas East Main Drain		X- Sacramento Regional Wastewater Treatment Plant	X-Natomas East Main Drain; Sacramento Slough; Colusa Basin Drain		water	89-93		Study of Drinking Water Quality in Delta Tributaries	California Urban Water Agencies	Brown & Caldwell Archibald & Wallberg Consultants Marvin Jung & Associates McGuire	1995

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Organics

CONSTITUENT	RECEIVING WATER DATA: SACRAMENTO	SAN JOAQUIN	DELTA	SF BAY	Creeks/Rivers	Discharge Water Quality Data: Stormwater	Rain/Fog	POTW	AG	Other	Water or Sediment	Time of Study	Notes	Title	Study ID	Author	Date
Carbofuran		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis			X- Multiple					X- TID #5 (dairy discharge)	water	3/91-4-91		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; March and April 1991		Lisa Ross	Nov-91
Carbofuran		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis, Maze Blvd.			X- Multiple					X- TID #5 (dairy discharge)	water	91-92		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; Winter 1991-2		Lisa Ross	May-92
Carbofuran		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis, Maze Blvd.			X- Multiple					X- TID #5 (dairy discharge)	water	92		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; Spring 1992		Lisa Ross	Apr-93
Carbofuran	X- above Colusa, Rio Vista, Mallard Island, Greens Landing		X- Barker Slough, Lindsay Slough						X- Drains in Delta, Colusa Basin Drain		water	83-90		Aquatic Toxicity and Pesticides in Surface Waters of the Central Valley	California Urban Water Agencies	J. Phyllis Fox, Elaine Archibald	Jul-96
Carbofuran		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis, Maze Blvd.			X- Multiple					X- TID #5 (dairy discharge)	water	92		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; Summer 1992		Lisa Ross	Sep-93
Carbofuran	X- Colusa Basin	X- Rio Vista	X-Chipps Isl.		X				X			90-92	Figures, at ricefield drainage basin and down stream, over time	Concentrations of Dissolved Rice Pesticides in the Colusa Basin and Sacramento River, California, 1990-92		Kathryn Crepeau, Kathryn Kuivila and Joseph Domalski	90-92
Carbofuran		X				X-AG						88-90	bioassay, drought years	Insecticide Concentrations and Invertebrate Bioassay Mortality in Agricultural Return Water from San Joaquin Basin		Central Valley RWQCB	1995
Carbofuran	X	X-Vernalis			x						water	91-94	samples taken near center of flow	Dissolved Pesticide Data for the San Joaquin River at Vernalis and the Sacramento River at Sacramento, CA, 1991-94	USGS 95-110	MacCoy, Crepeau, Kuivila	1995

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WATER QUALITY DATA SUMMARY
Organics

CONSTITUENT	RECEIVING WATER DATA					Discharge Water Quality Data					Water or	Time	Notes	Pub	Prepared	Author	Date
	SACRAMENTO	SAN JOAQUIN	DELTA	SF BAY	Creeks/Rivers	Stormwater	Rain/Fog	POTW	AG	Other	Sediment	of Study			For		
Carbofuran	multiple					X_runoff			x		water	1994	sites near ag.	Pesticides and Pesticide Degradation in Stormwater Run-off:Sacramento River Basin, CA	American Water Resources Assoc.	J. Domagalski	1996
Carbofuran			Chipps Isl		x						water	56-88	loads, distribution, flow, application and discharge rates	Distribution of Pesticides in the Sacramento=San Joaquin Delta	USGS Yearbook	K.Kuivila	1991
Carbofuran	X-Grimes									Applications	Water	70-88	Lots of info, few tables etc. species Pesticide sensitivity	The Effects of Toxic Contaminants in Water of the San Francisco Bay and Delta	Bay/Delta Oversight Council	H.C. Bally S. Clark J. Davis UC Davis Lan Wiborg AQUA-Science, DWR	1995
Chlordane								X				mostly 95	D. Sources, Ranges, Survey Data	Toxic Organic Constituent Literature Assessment	SFBAPPG/	Larry Walker Associates, Montgomery Watson	1996
Chlordanes	X- Freeport, Rio Vista	X-Stockton, Vernalis, Manteca		X-North, South, Central							water, sediment	1993		1993 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1993
Chlordanes	X- Freeport, Rio Vista	X-Stockton, Vernalis, Manteca		X-North, South, Central							water, sediment	1994		1994 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1994
Chlordanes	X	X		X-North, South, Central							water, sediment	1995		1995 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1995
Chlorodane	X	X	X		X	X- Fresno area	X- Fresno area				water, sediment	81-94		Aquatic Toxicity and Pesticides in Surface Waters of the Central Valley	California Urban Water Agencies	J. Phyllis Fox, Elaine Archibald	Jul-96
Chlorodane	X- Multiple	X- Multiple	X	X- San Pablo Bay								75-93	Available via internet www.iep.ca.gov	Interagency Ecological Program for the Sacramento San Joaquin Delta, Water Quality Monitoring Database METAFILE.DOC			

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WATER QUALITY DATA SUMMARY
Organics

CONSTITUENT	RECEIVING WATER DATA SACRAMENTO	SAN JOAQUIN	DELTA	SF BAY	Creeks/Rivers	Discharge Water Quality Data Stormwater	Rain/Fog	POTW	AG	Other	Water or Sediment	Time of Study	Notes	Paper	Prepared For	Author	Date
Chlorpyrifos	X	X-Stockton/S. Stockton		X	X	X	X					94/95	figures	Chlorpyrifos in Urban Storm Runoff		CRWQCB	1996
Chlorpyrifos				X						Sources-Urban		mostly 95	D. Sources, Ranges, Survey Data	Toxic Organic Constituent Literature Assessment	SFBAPPG	Larry Walker Associates, Montgomery Watson	1996
Chlorpyrifos		X				X-AG						88-90	bioassay, drought years	Insecticide Concentrations and Invertebrate Bioassay Mortality in Agricultural Return Water from San Joaquin Basin		Central Valley RWQCB	1995
Chlorpyrifos	Freeport, Colusa, Rio Vista	Vernalis, Modesto	Chipps Isl., Martinez	X	x							91-92	following rainfall, bioassay	Concentrations, Transport, and Biological Effects of Dormant Spray Pesticides in the SF Estuary, CA		Kathryn Kuivala, Christopher Foe	1994
Chlorpyrifos		Vernalis			x						water	92-93	Dispersion of pesticides following storms	Nonpoint Sources of Pesticides in the San Joaquin River, CA:input from Winter Storms, 1992-93	USGS/National WQAP	Joseph Domagalski	1995
Chlorpyrifos	X	X-Vernalis			x						water	91-94	samples taken near center of flow	Dissolved Pesticide Data for the San Joaquin River at Vernalis and the Sacramento River at Sacramento, CA, 1991-94	USGS 95-110	MacCoy, Crepeau, Kuivila	1995
Chlorpyrifos	X- Freeport, Rio Vista	X-Stockton, Vernalis, Manteca		X-North, South, Central							water	1993		1993 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1993
Chlorpyrifos		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis			X- Multiple					X- TID #5 (dairy discharge)	water	3/91-4/91		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; March and April 1991		Lisa Ross	Nov-91
Chlorpyrifos		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis, Maze Blvd.			X- Salt Slough, Mud Slough, Del Puerto Creek, Los Banos Creek, Merced River, Orestimba Creek, Tuolumne River, Stanislaus River, Newman Wasteway					X- TID #5 (dairy discharge)	water	91-92		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; Winter 1991-2		Lisa Ross	May-92

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WATER QUALITY DATA SUMMARY
Organics

CONSTITUENT	RECEIVING WATER DATA				Discharge Water Quality Data						Water or	Time	Notes	Title	Prod. for	Author	Date
	SACRAMENTO	SAN JOAQUIN	DELTA	SF BAY	Creeks/Rivers	Stormwater	Rain/Fog	POTW	AG	Other	Sediment	of Study					
Chlorpyrifos		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis, Maze Blvd.			X- Salt Slough, Mud Slough, Del Puerto Creek, Los Banos Creek. Merced River, Orestimba Creek, Tuolumne River, Stanislaus River, Newman Wasteway					X- TID #5 (dairy discharge)	water	92		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; Spring 1992		Lisa Ross	Apr-93
Chlorpyrifos					X- Rheem Creek (San Pablo Bay), Walnut Creek (Suisun Bay)						water	94-95		Contra Costa Clean Water Program FY 1995-1996 Monitoring Report		Woodward-Clyde Consultants	Apr-00
Chlorpyrifos	X	X							X-San Joaquin Basin		water	93-94		Aquatic Toxicity and Pesticides in Surface Waters of the Central Valley	California Urban Water Agencies	J. Phyllis Fox, Elaine Archibald	Jul-96
Chlorpyrifos		X- HWY 165, Fremont Ford, Hills Ferry, West Main, Laird Park, Maze Blvd, Airport Way			X- Orestimba Creek, Los Banos Creek, Ingram Hospital, Merced River, Del Puerto Creek, Tuolumne River, Stanislaus River, Newman Wasteway				X- TID #5 , Salt Slough, Mud Slough		water	91-92		CRWQCB Insecticide Concentrations and Invertebrate Bioassay Mortality in Agricultural Return Water from the San Joaquin Basin		Christopher Foe, CRWQCB	Dec-95
Chlorpyrifos		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis, Maze Blvd.			X- Salt Slough, Mud Slough, Del Puerto Creek, Los Banos Creek. Merced River, Orestimba Creek, Tuolumne River, Stanislaus River, Newman Wasteway					X- TID #5 (dairy discharge)	water	92		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; Summer 1992		Lisa Ross	Sep-93
Chlorpyrifos		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis, Maze Blvd.			X- Salt Slough, Mud Slough, Del Puerto Creek, Los Banos Creek. Merced River, Orestimba Creek, Tuolumne River, Stanislaus River, Newman Wasteway					X- TID #5 (dairy discharge)	water	92-93		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; Winter 1992-3		Lisa Ross	Sep-93
Chlorpyrifos	X				X						water			Sacramento Coordinated Water Quality Monitoring Program 1995 annual report	Sacramento Regional County Sanitation District Sac. County water Agency City of Sac	Larry Walker Associates	1996
Chlorpyrifos				X		urban runoff	X						toxicity data , flow, breakdown of use	Diazinon in Urban Areas	RWQCP	Ashli Cooper	Aug-96

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WATER QUALITY DATA SUMMARY
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CONSTITUENT	RECEIVING WATER DATA				Discharge Water Quality Data						Water or	Time	Notes	Report	Prepared For	Author	Date
	SACRAMENTO	SAN JOAQUIN	DELTA	SF BAY	Creeks/Rivers	Stormwater	Rain/Fog	POTW	AG	Other	Sediment	of Study					
Chlorpyrifos													Lots of info, few tables etc. species Pesticide sensitivity	The Effects of Toxic Contaminants in Water of the San Francisco Bay and Delta	Bay/Delta Oversight Council	H.C. Baily S. Clark J. Davis UC Davis Lan Wiborg AQUA-Science, DWR	1995
DDT	X- Freeport, Rio Vista	X-Stockton, Vernalis, Manteca		X-North, South, Central							water, sediment	1993		1993 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1993
DDT	X- Freeport, Rio Vista	X-Stockton, Vernalis, Manteca		X-North, South, Central							water, sediment	1994	.	1994 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1994
DDT	X	X		X-North, South, Central							water, sediment	1995		1995 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1995
DDT	X	X	X		X	X- Fresno area	X- Fresno area				water, sediment	83-94		Aquatic Toxicity and Pesticides in Surface Waters of the Central Valley	California Urban Water Agencies	J. Phyllis Fox, Elaine Archibald	Jul-96
DDT								X				mostly 95	D. Sources, Ranges, Survey Data	Toxic Organic Constituent Literature Assessment	SFBAPPG/	Larry Walker Associates, Montgomery Watson	1996
DDT	X- Multiple	X- Multiple	X	X- San Pablo Bay								75-93	Available via internet www.iep.ca.gov	Interagency Ecological Program for the Sacramento San Joaquin Delta. Water Quality Monitoring Database METAFILE.DOC			
Diazinon	X- Freeport, Rio Vista	X-Stockton, Vernalis, Manteca		X-North, South, Central							water	1994		1994 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1994
Diazinon	X	X		X-North, South, Central							water	1995		1995 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1995

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WATER QUALITY DATA SUMMARY
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CONSTITUENT	RECEIVING WATER DATA SACRAMENTO	SAN JOAQUIN	DELTA	SF BAY	Discharge Water Quality Data Creeks/Rivers	Stormwater	Rain/Fog	POTW	AG	Other	Water or Sediment	Time of Study	Notes	Report	Prepared For	Author	Date
Diazinon	X- Veterans Bridge, Freeport Marina, River Mile 44										water	94-95		Sacramento Coordinated Water Quality Monitoring Program 1995 Annual Report	Sacramento Regional County Sanitation District, Sacramento County Water Agency, City of Sacramento	Larry Walker Associates	Feb-96
Diazinon		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis			X- Multiple					X- TID #5 (dairy discharge)	water	3/91-4/91		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; March and April 1991		Lisa Ross	Nov-91
Diazinon		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis, Maze Blvd.			X- Multiple					X- TID #5 (dairy discharge)	water	91-92		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; Winter 1991-2		Lisa Ross	May-92
Diazinon		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis, Maze Blvd.			X- Multiple					X- TID #5 (dairy discharge)	water	92		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; Spring 1992		Lisa Ross	Apr-93
Diazinon					X- Rheem Creek (San Pablo Bay), Walnut Creek (Suisun Bay)						water	94-95		Contra Costa Clean Water Program FY 1995-1996 Monitoring Report		Woodward-Clyde Consultants	Apr-00
Diazinon	X	X			X	X- Sacramento, Stockton, Fresno area	X- Patterson, Tracy, Stockton, Sacramento, Fresno area		X- Drains in Delta, San Joaquin Basin		water	81-94		Aquatic Toxicity and Pesticides in Surface Waters of the Central Valley	California Urban Water Agencies	J. Phyllis Fox, Elaine Archibald	Jul-96
Diazinon		X- HWY 165, Fremont Ford, Hills Ferry, West Main, Laird Park, Maze Blvd, Airport Way			X- Orestimba Creek, Los Banos Creek, Ingram Hospital, Merced River, Del Puerto Creek, Tuolumne River, Stanislaus River, Newman Wasteway				X- TID #5 , Salt Slough, Mud Slough		water	91-92		CRWQCB Insecticide Concentrations and Invertebrate Bioassay Mortality in Agricultural Return Water from the San Joaquin Basin		Christopher Foe, CRWQCB	Dec-95
Diazinon		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis, Maze Blvd.			X- Salt Slough, Mud Slough, Del Puerto Creek, Los Banos Creek, Merced River, Orestimba Creek, Tuolumne River, Stanislaus River, Newman Wasteway					X- TID #5 (dairy discharge)	water	92		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; Summer 1992		Lisa Ross	Sep-93

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WATER QUALITY DATA SUMMARY
Organics

CONSTITUENT	RECEIVING WATER DATA				Discharge Water Quality Data						Water or Sediment	Time of Study	Notes	Report	Prepared For	Author	Date
	SACRAMENTO	SAN JOAQUIN	DELTA	SF BAY	Creeks/Rivers	Stormwater	Rain/Fog	POTW	AG	Other							
Diazinon		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis, Maze Blvd.			X- Salt Slough, Mud Slough, Del Puerto Creek, Los Banos Creek, Merced River, Orestimba Creek, Tuolumne River, Stanislaus River, Newman Wasteway					X- TID #5 (dairy discharge)	water	92-93		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; Winter 1992-3		Lisa Ross	Sep-93
Diazinon	X	X-Stockton/S. Stockton		X		X						94/95	figures	Chlorpyrifos in Urban Storm Runoff		CRWQCB	1996
Diazinon	X- Multiple Locations	X-Multiple Locations					X	Deep, shallow and ocean water discharge				mostly 95	D. Sources, Ranges, Survey Data	Toxic Organic Constituent Literature Assessment	SFBAPPG/	Larry Walker Associates, Montgomery Watson	1996
Diazinon		X				X-AG						88-90	bioassay, drought years	Insecticide Concentrations and Invertebrate Bioassay Mortality in Agricultural Return Water from San Joaquin Basin		Central Valley RWQCB	1995
Diazinon				X-Multiple				X-URBAN				95-96	POTW	?? Draft		??-Ask Bart	
Diazinon	Freeport, Colusa, Rio Vista	Vernalis, Modesto	Chipps Isl.,Martinez	X	X							91-92	following rainfall, bioassay	Concentrations, Transport, and Biological Effects of Dormant Spray Pesticides in the SF Estuary, CA		Kathryn Kuivala, Christopher Foe	1994
Diazinon	Sacramento, Rio Vista Freeport, Colusa	Vernalis, Modesto	Chipps Isl.,Martinez	x	x						water	93	following rainfall, measurements downstream	Diazinon Concentrations in the Sacramento and San Joaquin Rivers and SF Bay, CA February 1993	USGS-	Kathryn Kuivala	1993
Diazinon		Vernalis			x							92-93	Dispersion of pesticides following storms	Nonpoint Sources of Pesticides in the San Joaquin River, CA:Input from Winter Storms, 1992-93	USGS/National WQAP	Joseph Domagalski	1995
Diazinon	X	X-Vernalis			x						water	91-94	samples taken near center of flow	Dissolved Pesticide Data for the San Joaquin River at Vernalis and the Sacramento River at Sacramento, CA, 1991-94	USGS 95-110	MacCoy, Crepeau, Kuivila	1995
Diazinon	multiple					X-runoff			x		water	1994	sites near ag.	Pesticides and Pesticide Degradation in Stormwater Run-off:Sacramento River Basin, CA	American Water Resources Assoc.	J. Domagalski	1996

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WATER QUALITY DATA SUMMARY
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CONSTITUENT	RECEIVING WATER DATA				Discharge Water Quality Data						Water or Sediment	Time of Study	Notes	Paper	Prepared For	Author	DATE
	SACRAMENTO	SAN JOAQUIN	DELTA	SF BAY	Creeks/Rivers	Stormwater	Rain/Fog	POTW	AG	Other							
Diazinon				Castro Valley	X	X- Urban/Street gutter	X-Run-off					95-96	Seasonal, rainy season, Flow	Characterization of Insecticide Use and Presence in the Castro Valley Creek Watershed	Alameda County Flood Control and Water Conservation District	J. Scanlin	1996?
Diazinon			Chipps Isl		x						water	56-88	loads, distribution, flow, application and discharge rates	Distribution of Pesticides in the Sacramento-San Joaquin Delta	USGS Yearbook	K.Kuivila	1991
Diazinon													Lots of info, few tables etc. species Pesticide sensitivity	The Effects of Toxic Contaminants in Water of the San Francisco Bay and Delta	Bay/Delta Oversight Council	H.C. Baily S. Clark J. Davis UC Davis Lan Wiborg AQUA-Science, DWR	1995
Diazinon				X		urban runoff	X						toxicity data, flow, breakdown of use	Diazinon in Urban Areas	RWQCP	Ashli Cooper	Aug-96
Diazinon	X				X						water			Sacramento Coordinated Water Quality Monitoring Program 1995 annual report	Sacramento Regional County Sanitation District Sac. County water Agency City of Sac	Larry Walker Associates	1996
Fecal Coliform						X- 5 locations representing residential, commercial and industrial land uses					water	10/92-2/93		Municipal Storm Water Discharge Management Program Technical Memorandum Task 3.1 Storm Water Characterization Study	Camp, Dresser & McKee, Inc.	Kinetic Laboratories, Inc.	Jan-94
Fecal Streptococcus						X- 5 locations representing residential, commercial and industrial land uses					water	10/92-2/93		Municipal Storm Water Discharge Management Program Technical Memorandum Task 3.1 Storm Water Characterization Study	Camp, Dresser & McKee, Inc.	Kinetic Laboratories, Inc.	Jan-94
Pathogens	X- Greens Landing		X- Banks Pumping Plant; Delta Mendota Canal							X- Checkpoint 29?	water	92-93		Study of Drinking Water Quality in Delta Tributaries	California Urban Water Agencies	Brown & Caldwell Archibald & Wallberg Consultants Marvin Jung & Associates McGuire Environmental Consultants, Inc	1995

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WATER QUALITY DATA SUMMARY
Organics

CONSTITUENT	RECEIVING WATER DATA					Discharge Water Quality Data					Water or Sediment	Time of Study	Notes	Paper	Prepared For	Author	Date
	SACRAMENTO	SAN JOAQUIN	DELTA	SF BAY	Creeks/Rivers	StormWater	Rain/Fog	POTW	AG	Other							
PCBs	X- Freeport, Rio Vista	X-Stockton, Vernalis, Manteca		X-North, South, Central							water, sediment	1993		1993 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1993
PCBs	X- Freeport, Rio Vista	X-Stockton, Vernalis, Manteca		X-North, South, Central							water, sediment	1994		1994 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1994
PCBs	X	X		X-North, South, Central							water, sediment	1995		1995 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1995
PCBs	X	X	X		X						water	83-87		Aquatic Toxicity and Pesticides in Surface Waters of the Central Valley	California Urban Water Agencies	J. Phyllis Fox, Elaine Archibald	Jul-96
PCBs	X- Multiple	X- Multiple	X	X- San Pablo Bay								75-93	Available via internet www.iep.ca.gov	Interagency Ecological Program for the Sacramento San Joaquin Delta. Water Quality Monitoring Database METAFILE.DOC			
Total Coliform						X- 5 locations representing residential, commercial and industrial land uses					water	10/92-2/93		Municipal Storm Water Discharge Management Program Technical Memorandum Task 3.1 Storm Water Characterization Study	Camp, Dresser & McKee, Inc.	Kinetic Laboratories, Inc.	Jan-94
Toxaphene	X- Freeport, Rio Vista	X-Stockton, Vernalis, Manteca		X-North, South, Central							water	1993		1993 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1993
Toxaphene	X- Freeport, Rio Vista	X-Stockton, Vernalis, Manteca		X-North, South, Central							water	1994		1994 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1994
Toxaphene		X				X- Fresno area	X- Fresno area				water, sediment	81- 85		Aquatic Toxicity and Pesticides in Surface Waters of the Central Valley	California Urban Water Agencies	J. Phyllis Fox, Elaine Archibald	Jul-96

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WATER QUALITY DATA SUMMARY
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CONSTITUENT	RECEIVING WATER DATA				Discharge Water Quality Data						Water or	Time	Notes	Report	Prepared	Author	Date
	SACRAMENTO	SAN JOAQUIN	DELTA	SF BAY	Creeks/Rivers	Stormwater	Rain/Fog	POTW	AG	Other	Sediment	of Study			For		
Toxaphene	X- Multiple	X- Multiple	X	X- San Pablo Bay								75-93	Available via Internet www.iep.ca.gov	Interagency Ecological Program for the Sacramento San Joaquin Delta. Water Quality Monitoring Database METAFILE.DOC			
Toxaphene													D. Sources, Ranges, Survey Data	Toxic Organic Constituent Literature Assessment	SFBAPPG	Larry Walker Associates, Montgomery Watson	1996

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WATER QUALITY DATA SUMMARY
Metals

CONSTITUENT	RECEIVING WATER DATA: SACRAMENTO	SAN JOAQUIN	DELTA	SF BAY	Discharge Water Quality Data: Creeks	Stormwater	Rain/Fog	POTW	AG	Other	Water or Sediment	Time of Study	Notes	Paper	Prepared For	Author	Date
Cadmium	X- Freeport, Rio Vista	X-Stockton, Vernalis, Manteca		X-North, South, Central							water, sediment	1993		1993 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	Jun-05
Cadmium	X- Freeport, Rio Vista	X-Stockton, Vernalis, Manteca		X-North, South, Central							water, sediment	1994		1994 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	Jun-05
Cadmium	X	X		X-North, South, Central							water, sediment	1995		1995 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	Jun-05
Cadmium	X- Veterans Bridge, Freeport Marina, River Mile 44										water	94-95		Sacramento Coordinated Water Quality Monitoring Program 1995 Annual Report	Sacramento Regional County Sanitation District Sacramento County Water Agency City of Sacramento	Larry Walker Associates	Feb-96
Cadmium					X-Spring Creek, Keswick Reservoir, Keswick Dam (Sacramento)						water	79-80		Evaluation of Lethal Levels, Release Criteria, and Water Quality Objectives for an Acid Mine Waste in *Aquatic Toxicology and Environmental Fate: Eleventh Volume*, ASTM STP 1007, pp. 189-203		Brian J. Finlayson, Dennis C. Wilson	Jun-05
Cadmium						X- 5 locations representing residential, commercial and industrial land uses					water	10-92/2-93		Municipal Storm Water Discharge Management Program Technical Memorandum Task 3.1 Storm Water Characterization Study	Camp, Dresser & McKee, Inc.	Kinetic Laboratories, Inc.	Jan-94
Cadmium						X- 5 Sacramento Storm Drains			X- Drains in Sacramento Valley	X- NPDES dischargers-industrial self-monitoring data		87		Draft State Report CRWQCB A Mass Loading Assessment Of Major Point And Non-Point Sources Discharging To Surface Waters In The Central Valley, California, 1985		Barry Montoya, Fred Blatt, Gregory Harris	Oct-88
Cadmium					X- Receiving waters below Sacramento Valley mines					X- Mine Drainage, Shasta Dam	water	86-90	Also list waste rock concentrations	CRWQCB, Central Valley Region Standards, Policies, and Special Studies Unit, Inactive Mine Drainage in the Sacramento Valley, California		Barry Montoya, Xiamang Pan	Jul-92
Cadmium					X- Rheem Creek (San Pablo Bay), Walnut Creek (Suisun Bay)						water	94-95		Contra Costa Clean Water Program FY 1994-1995 Monitoring Report		Woodward-Clyde Consultants	Sep-95

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CONSTITUENT	RECEIVING WATER DATA SACRAMENTO	SAN JOAQUIN	DELTA	SF BAY	Discharge Water Quality Data Creeks	Stormwater	Rain/Fog	POTW	AG	Other	Water or Sediment	Time of Study	Notes	Paper	Prepared For	Author	Date
Cadmium					X- Rheem Creek (San Pablo Bay), Walnut Creek (Suisun Bay)						water	94-95		Contra Costa Clean Water Program FY 1995-1996 Monitoring Report		Woodward-Clyde Consultants	96
Cadmium	X-									mines	water		Effects on fish	Evaluation of Lethal Levels, release Criteria, and Water Quality Objectives for an Acid-Mine Waste		B.J. Finlayson D. C. Wilson	1989
Cadmium	X				X						water			Sacramento Coordinated Water Quality Monitoring Program 1995 annual report	Sacramento Regional County Sanitation District Sac. County water Agency City of Sac	Larry Walker Associates	1996
Cadmium	X- Multiple	X- Multiple	X	X- San Pablo Bay								75-93	Available via internet www.iep.ca.gov	Interagency Ecological Program for the Sacramento San Joaquin Delta. Water Quality Monitoring Database METAFILE.DOC			
Copper	X- Freeport, Rio Vista	X-Stockton, Vernalis, Manteca		X-North, South, Central							water, sediment	1993		1993 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	Jun-05
Copper	X- Freeport, Rio Vista	X-Stockton, Vernalis, Manteca		X-North, South, Central							water, sediment	1994		1994 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	Jun-05
Copper	X	X		X-North, South, Central							water, sediment	1995		1995 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	Jun-05
Copper	X- Veterans Bridge, Freeport Marina, River Mile 44										water	94-95		Sacramento Coordinated Water Quality Monitoring Program 1995 Annual Report	Sacramento Regional County Sanitation District Sacramento County Water Agency City of Sacramento	Larry Walker Associates	Feb-96
Copper					X-Spring Creek, Keswick Reservoir, Keswick Dam (Sacramento)						water	79-80		Evaluation of Lethal Levels, Release Criteria, and Water Quality Objectives for an Acid Mine Waste in *Aquatic Toxicology and Environmental Fate: Eleventh Volume*, ASTM STP 1007, pp. 189-203		Brian J. Finlayson, Dennis C. Wilson	Jun-05

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WATER QUALITY DATA SUMMARY
Metals

CONSTITUENT	RECEIVING WATER DATA SACRAMENTO	SAN JOAQUIN	DELTA	SF BAY	Creeks	Discharge Water Quality Data Stormwater	Rain/Fog	POTW	AG	Other	Water or Sediment	Time of Study	Notes	Paper	Prepared For	Author	Date
Copper		X- Stevenson									water	87-88		Water-Quality Data, San Joaquin Valley, California, April 1987 to September 1988		USGS, Regional Aquifer-System Analysis San Joaquin Valley Drainage Program	
Copper						X- 5 locations representing residential, commercial and industrial land uses					water	10-92/2-93		Municipal Storm Water Discharge Management Program Technical Memorandum Task 3.1 Storm Water Characterization Study	Camp, Dresser & McKee, Inc.	Kinetic Laboratories, Inc.	Jan-94
Copper						X- 5 Sacramento Storm Drains			X- Drains in Sacramento Valley	X- NPDES dischargers-industrial self-monitoring data		87		Draft Staff Report CRWQCB A Mass Loading Assessment Of Major Point And Non-Point Sources Discharging To Surface Waters In The Central Valley, California, 1985		Barry Montoya, Fred Blatt, Gregory Harris	Oct-88
Copper					X- Receiving waters below Sacramento Valley mines					X- Mine Drainage, Shasta Dam	water	86-90	Also list waste rock concentrations	CRWQCB, Central Valley Region Standards, Policies, and Special Studies Unit, Inactive Mine Drainage in the Sacramento Valley, California		Barry Montoya, Xiamang Pan	Jul-92
Copper					X- Rheem Creek (San Pablo Bay), Walnut Creek (Suisun Bay)						water	94-95		Contra Costa Clean Water Program FY 1994-1995 Monitoring Report		Woodward-Clyde Consultants	Sep-95
Copper					X- Rheem Creek (San Pablo Bay), Walnut Creek (Suisun Bay)						water	94-95		Contra Costa Clean Water Program FY 1995-1996 Monitoring Report		Woodward-Clyde Consultants	96
Copper	X-									mines	water		Effects on fish	Evaluation of Lethal Levels, release Criteria, and Water Quality Objectives for an Acid-Mine Waste		B.J. Finlayson D. C. Wilson	1989
Copper	X- Multiple	X- Multiple	X	X- San Pablo Bay								75-93	Available via internet www.iep.ca.gov	Interagency Ecological Program for the Sacramento San Joaquin Delta. Water Quality Monitoring Database METAFILE.DOC			
Copper	X				X						water			Sacramento Coordinated Water Quality Monitoring Program 1995 annual report	Sacramento Regional County Sanitation District Sac. County water Agency City of Sac	Larry Walker Associates	1996
Mercury	X- Freeport, Rio Vista	X-Stockton, Vernalis, Manteca		X-North, South, Central							water, sediment	1993		1993 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	Jun-9[illegible]

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WATER QUALITY DATA SUMMARY
Metals

CONSTITUENT	RECEIVING WATER DATA: SACRAMENTO	SAN JOAQUIN	DELTA	SF BAY	Discharge Water Quality Data: Creeks	StormWater	Rain/Fog	POTW	AG	Other	Water or Sediment	Time of Study	Notes	Paper	Prepared For	Author	Date
Mercury	X- Freeport, Rio Vista	X-Stockton, Vernalis, Manteca		X-North, South, Central							water, sediment	1994		1994 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	Jun-05
Mercury	X	X		X-North, South, Central							water, sediment	1995		1995 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	Jun-05
Mercury	X- Veterans Bridge, Freeport Marina, River Mile 44										water	94-95		Sacramento Coordinated Water Quality Monitoring Program 1995 Annual Report	Sacramento Regional County Sanitation District Sacramento County Water Agency City of Sacramento	Larry Walker Associates	Feb-96
Mercury		X- Stevenson									water	87-88		Water-Quality Data, San Joaquin Valley, California, April 1987 to September 1988		USGS, Regional Aquifer-System Analysis San Joaquin Valley Drainage Program	
Mercury						X- 5 locations representing residential, commercial and industrial land uses					water	10-92/2-93		Municipal Storm Water Discharge Management Program Technical Memorandum Task 3.1 Storm Water Characterization Study	Camp, Dresser & McKee, Inc.	Kinetic Laboratories, Inc.	Jan-94
Mercury						X- 5 Sacramento Storm Drains			X- Drains in Sacramento Valley	X- NPDES dischargers-industrial self-monitoring data		87		Draft State Report CRWQCB A Mass Loading Assessment Of Major Point And Non-Point Sources Discharging To Surface Waters In The Central Valley, California, 1985		Barry Montoya, Fred Blatt, Gregory Harris	Oct-88
Mercury					X- Rheem Creek (San Pablo Bay), Walnut Creek (Suisun Bay)						water	94-95		Contra Costa Clean Water Program FY 1994-1995 Monitoring Report		Woodward-Clyde Consultants	Sep-95
Mercury					X- Rheem Creek (San Pablo Bay), Walnut Creek (Suisun Bay)						water	94-95		Contra Costa Clean Water Program FY 1995-1996 Monitoring Report		Woodward-Clyde Consultants	96
Mercury	X- Multiple	X- Multiple	X	X- San Pablo Bay								75-93	Available via internet www.iep.ca.gov	Interagency Ecological Program for the Sacramento San Joaquin Delta, Water Quality Monitoring Database METAFILE.DOC			

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WATER QUALITY DATA SUMMARY
Metals

CONSTITUENT	RECEIVING WATER DATA				Discharge Water Quality Data						Water or	Time	Notes	Paper	Prepared	Author	Date
	SACRAMENTO	SAN JOAQUIN	DELTA	SF BAY	Creeks	Stormwater	Rain/Fog	POTW	AG	Other	Sediment	of Study			For		
Mercury	X				X						water			Sacramento Coordinated Water Quality Monitoring Program 1995 annual report	Sacramento Regional County Sanitation District Sac. County water Agency City of Sac	Larry Walker Associates	1996
Selenium	X- Freeport, Rio Vista	X-Stockton, Vernalis, Manteca		X-North, South, Central							water, sediment	1993		1993 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	Jun-05
Selenium	X- Freeport, Rio Vista	X-Stockton, Vernalis, Manteca		X-North, South, Central							water, sediment	1994		1994 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	Jun-05
Selenium	X	X		X-North, South, Central							water, sediment	1995		1995 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	Jun-06
Selenium	X- Veterans Bridge, Freeport Marina, River Mile 44										water	94-95		Sacramento Coordinated Water Quality Monitoring Program 1995 Annual Report	Sacramento Regional County Sanitation District Sacramento County Water Agency City of Sacramento	Larry Walker Associates	Feb-96
Selenium		X- Stevenson									water	87-88		Water-Quality Data, San Joaquin Valley, California, April 1987 to September 1988		USGS, Regional Aquifer-System Analysis San Joaquin Valley Drainage Program	
Selenium						X- 5 locations representing residential, commercial and industrial land uses					water	10-92/2-93		Municipal Storm Water Discharge Management Program Technical Memorandum Task 3.1 Storm Water Characterization Study	Camp, Dresser & McKee, Inc.	Kinetic Laboratories, Inc.	Jan-94
Selenium						X- 5 Sacramento Storm Drains			X- Drains in Sacramento Valley	X- NPDES dischargers-industrial self-monitoring data		87		Draft State Report CRWQCB A Mass Loading Assessment Of Major Point And Non-Point Sources Discharging To Surface Waters In The Central Valley, California, 1985		Barry Montoya, Fred Blatt, Gregory Harris	Oct-88
Selenium					X- Rheem Creek (San Pablo Bay), Walnut Creek (Suisun Bay)						water	94-95		Contra Costa Clean Water Program FY 1994-1995 Monitoring Report		Woodward-Clyde Consultants	Sep-95

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CALFED
WATER QUALITY DATA SUMMARY
Metals

CONSTITUENT	RECEIVING WATER DATA SACRAMENTO	SAN JOAQUIN	DELTA	SF BAY	Creeks	Discharge Water Quality Data Stormwater	Rain/Fog	POTW	AG	Other	Water or Sediment	Time of Study	Notes	Paper	Prepared For	Author	Date
Selenium					X- Rheem Creek (San Pablo Bay), Walnut Creek (Suisun Bay)						water	94-95		Contra Costa Clean Water Program FY 1995-1996 Monitoring Report		Woodward-Clyde Consultants	96
Selenium		X-Veranlis, multiple										1985-87	low/high flow, mud and salt sloughs	Sources and Concentrations of Selenium in the San Joaquin River	USGS	Saphen Clifton, Robert Gilliom	1988
Selenium	X				X						water			Sacramento Coordinated Water Quality Monitoring Program 1995 annual report	Sacramento Regional County Sanitation District Sac. County water Agency City of Sac	Larry Walker Associates	1996
Zinc	X- Freeport, Rio Vista	X-Stockton, Vernalis, Manteca		X-North, South, Central							water, sediment	1993		1993 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	Jun-05
Zinc	X- Freeport, Rio Vista	X-Stockton, Vernalis, Manteca		X-North, South, Central							water, sediment	1994		1994 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	Jun-05
Zinc	X	X		X-North, South, Central							water, sediment	1995		1995 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	Jun-05
Zinc	X- Veterans Bridge, Freeport Marina, River Mile 44										water	94-95		Sacramento Coordinated Water Quality Monitoring Program 1995 Annual Report	Sacramento Regional County Sanitation District Sacramento County Water Agency City of Sacramento	Larry Walker Associates	Feb-96
Zinc					X-Spring Creek, Keswick Reservoir, Keswick Dam (Sacramento)						water	79-80		Evaluation of Lethal Levels, Release Criteria, and Water Quality Objectives for an Acid Mine Waste in *Aquatic Toxicology and Environmental Fate: Eleventh Volume*, ASTM STP 1007, pp. 189-203		Brian J. Finlayson, Dennis C. Wilson	Jun-08
Zinc		X- Stevenson									water	87-88		Water-Quality Data, San Joaquin Valley, California, April 1987 to September 1988		USGS, Regional Aquifer-System Analysis San Joaquin Valley Drainage Program	
Zinc						X- 5 locations representing residential, commercial and industrial land uses					water	10-92/2-93		Municipal Storm Water Discharge Management Program Technical Memorandum Task 3.1 Storm Water Characterization Study	Camp, Dresser & McKee, Inc.	Kinetic Laboratories, Inc.	Jan-94

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CALFED
WATER QUALITY DATA SUMMARY
Metals

CONSTITUENT	RECEIVING WATER DATA					Discharge Water Quality Data					Water/	Time	Notes	Paper	Prepared	Author	Date
	SACRAMENTO	SAN JOAQUIN	DELTA	SF BAY	Creeks	Stormwater	Rain/Fog	POTW	AG	Other	Sediment	of Study			For		
Zinc						X- 5 Sacramento Storm Drains			X- Drains in Sacramento Valley	X- NPDES dischargers-industrial self-monitoring data		87		Draft State Report CRWQCB A Mass Loading Assessment Of Major Point And Non-Point Sources Discharging To Surface Waters In The Central Valley, California, 1985		Barry Montoya, Fred Blatt, Gregory Harris	Oct-88
Zinc					X- Receiving waters below Sacramento Valley mines					X- Mine Drainage, Shasta Dam	water	86-90	Also list waste rock concentrations	CRWQCB, Central Valley Region Standards, Policies, and Special Studies Unit, Inactive Mine Drainage in the Sacramento Valley, California		Barry Montoya, Xiamang Pan	Jul-92
Zinc					X- Rheem Creek (San Pablo Bay), Walnut Creek (Suisun Bay)						water	94-95		Contra Costa Clean Water Program FY 1994-1995 Monitoring Report		Woodward-Clyde Consultants	Sep-95
Zinc					X- Rheem Creek (San Pablo Bay), Walnut Creek (Suisun Bay)						water	94-95		Contra Costa Clean Water Program FY 1995-1996 Monitoring Report		Woodward-Clyde Consultants	96
Zinc	X- Multiple	X- Multiple	X	X- San Pablo Bay								75-93	Available via internet www.iep.ca.gov	Interagency Ecological Program for the Sacramento San Joaquin Delta. Water Quality Monitoring Database METAFILE.DOC			
Zinc	X-									mines	water		Effects on fish	Evaluation of Lethal Levels, release Criteria, and Water Quality Objectives for an Acid-Mine Waste		B.J. Finlayson D. C. Wilson	1989
Zinc	X				X						water			Sacramento Coordinated Water Quality Monitoring Program 1995 annual report	Sacramento Regional County Sanitation District Sac. County water Agency City of Sac	Larry Walker Associates	1996

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WATER QUALITY AND SEDIMENT DATA AT VARIOUS DELTA LOCATIONS

Following are minimum, maxaimum, mean and standard deviation values for water quality and sediment data from monitoring locations throughout the Delta. This data was compiled from the following sources. This data will be used in the PEIS to compare change in parameters of concern at various points in the Delta due to different alternative configurations.

Sources for Water Quality Data

San Francisco Estuary Institute, Annual Reports 1993 through 1995.

USGS data collected on Sac R. @ Freeport. Data was obtained from their web page.

Sacramento Coordinated Water Quality Monitoring Program 1995 Annual Report

DWR Municipal Water Quality Investigations Program. Data generated by this program was supplied by Collette Zemitis of DWR-DLA.

Sources for Sediment Data

DWR Interim North and South Delta Programs

Environmental Study for the Interim South Delta Program: Water, Sediment, and Soil Quality, DWR-DLA, 5/94

Water and Sediment Quality Study for the Interim South Delta Program, DWR 5/95

Environmental Study of Dredged Materials in Old River, Interim South Delta Program, DWR, 5/97

Environmental Study for the Staten Island SRAH Test Project Phase II, Water Sediment and Soil Quality Report, 8/94

Environmental Study for the Interim North Delta Program, Water Sediment and Soil Quality, DWR 5/95

Reports and data supplied by Collette Zemitis of DWR-DLA

San Francisco Estuary Institute, Annual Reports 1993 through 1995.

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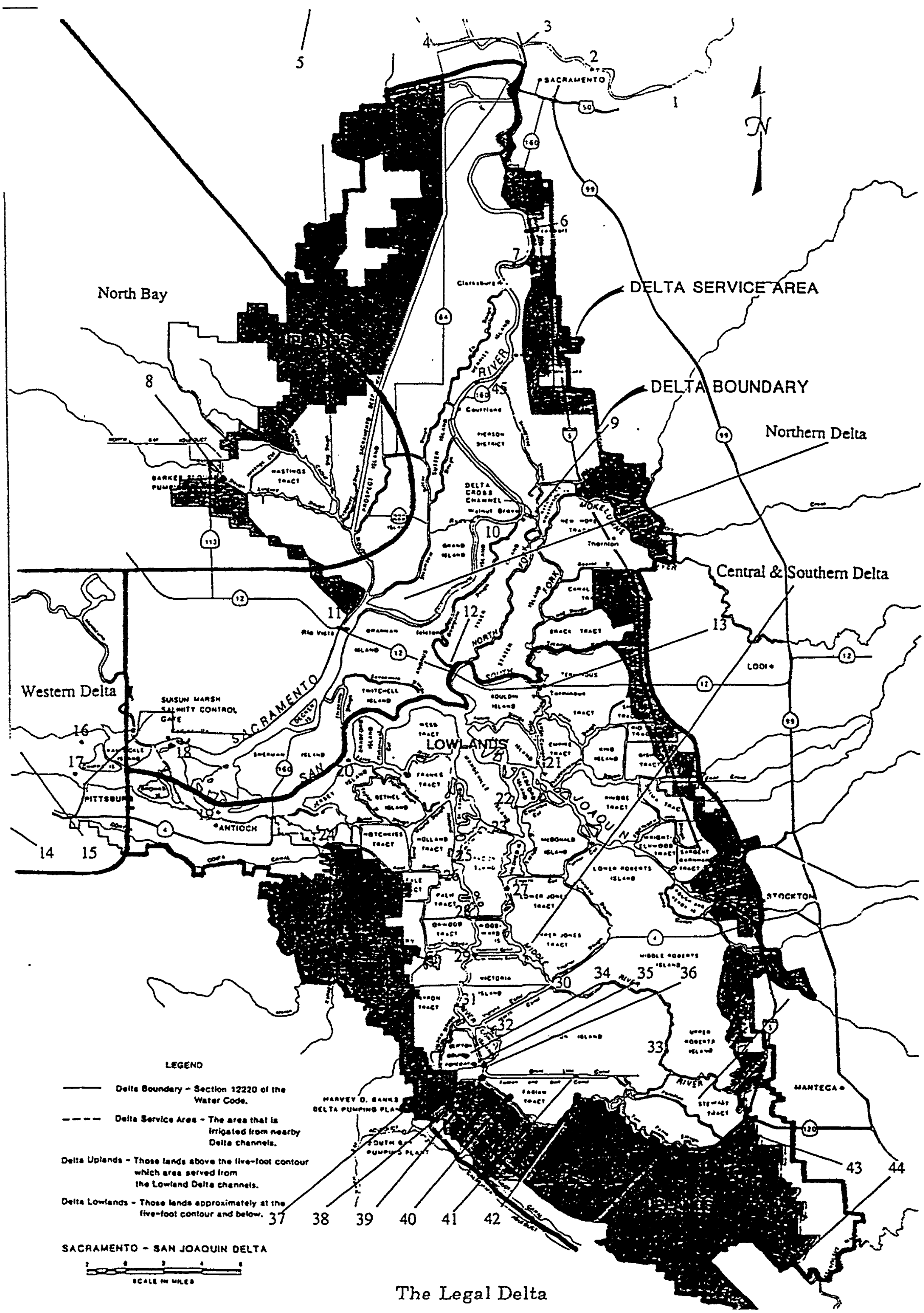
WATER QUALITY MONITORING LOCATIONS



The Legal Delta

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Station No.	Location	Monitoring Agency or Program	Station Name
1	Outside delta	CMP	Nimbus
2	Outside delta	DWR	American River WTP
3	Outside delta	CMP	Discovery Park
4	Outside delta	DWR	Sacramento River @ W. Sac Intake
5	Outside delta	CMP	Sacramento River @ Veterans Bridge (outside map area)
6	Northern Delta	CMP	Sacramento River @ Freeport Marina
6	Northern Delta	USGS	Sacramento River @ Freeport Marina
7	Northern Delta	CMP	Sacramento River Mile 44
8	North Bay	DWR	Barker Sl. @ North Bay PP
9	Northern Delta	DWR	Delta Cross Channel nr Walnut Grove
10	Northern Delta	DWR	Georgiana Sl. @ Walnut Grove Bridge
11	Northern Delta	DWR	Sacramento River @ Rio Vista Bridge
12	Northern Delta	DWR	Mokelumne R. below Georgiana Sl.
13	Central and Southern Delta	DWR	Little Potato Sl. @ Terminous
14	Western Delta	SFEI	Pacheco Creek (outside area map)
15	Western Delta	SFEI	Grizzly Bay
16	Western Delta	SFEI	Honker Bay
17	Western Delta	DWR	Sacramento River @ Mallard Island
18	Northern Delta	SFEI	Sacramento River @ Collinsville
19	Central and Southern Delta	SFEI	San Joaquin River @ Antioch
20	Central and Southern Delta	DWR	San Joaquin River @ Jersey Point
21	Central and Southern Delta	DWR	Little Connection Sl. @ Empire Tract
22	Central and Southern Delta	DWR	Middle R. nr Latham Sl.
23	Central and Southern Delta	DWR	Connection Sl. @ Mandeville Is. Bridge
24	Central and Southern Delta	DWR	Contra Costa PP #01
25	Central and Southern Delta	DWR	Old R. N/O Rock Sl. (St 4b)
26	Central and Southern Delta	DWR	Rock Sl. @ Old R.
27	Central and Southern Delta	DWR	Middle R. @ Bacon Is. Br.
28	Central and Southern Delta	DWR	Santa Fe-Bacon Is. Cut nr Old R.
29	Central and Southern Delta	DWR	Woodward/N. Victoria Canal nr Old R.
30	Central and Southern Delta	DWR	Middle R. @ Borden Hwy
31	Central and Southern Delta	DWR	Old R. nr Byron (St 9)
32	Central and Southern Delta	DWR	North Canal nr Old R.
33	Central and Southern Delta	DWR	Middle R. @ Mowry Br.
34	Central and Southern Delta	DWR	Clifton Court Intake
35	Central and Southern Delta	DWR	West Canal @ Clifton Court FB Intake
36	Central and Southern Delta	DWR	Old R. 6/10 mile below DMC intake
37	SWP	DWR	Delta PP Headworks
38	CVP	DWR	DMC Intake @ Lindemann Rd
39	Central and Southern Delta	DWR	Grant Line/Fabian/Bell Canals nr Old R.
40	Central and Southern Delta	DWR	Old R. U/S from DMC Intake
41	Central and Southern Delta	DWR	Grant Line Can @ Tracy Rd Br.
42	Central and Southern Delta	DWR	Old R. nr Tracy
43	Central and Southern Delta	DWR	San Joaquin R. @ Mossdale Br.
44	Central and Southern Delta	DWR	San Joaquin R. nr Vernalis
44	Central and Southern Delta	USGS	San Joaquin R. nr Vernalis
45	Northern Delta	DWR	Sacramento R. at Greenes Landing

DISSOLVED ORGANIC CARBON

Form	Unit	Area	Station Number	Station Name	Record Period Start	Record Period End	Count	Min	Max	Mean	Standard Deviation
	mg/L	Central and Southern Delta	13	Little Potato Sl. @ Terminous	1988	1994	49	1.6	8.90	2.85	1.22
	mg/L	Central and Southern Delta	20	San Joaquin R. @ Jersey Point	1990	1994	77	1.9	6.20	3.12	0.96
	mg/L	Central and Southern Delta	21	Little Connection Sl. @ Empire Tr.	1986	1994	68	1.2	10.90	3.38	1.61
	mg/L	Central and Southern Delta	24	Contra Costa PP #01	1990	1996	87	2.3	9.10	3.91	1.22
	mg/L	Central and Southern Delta	25	Old R. N/O Rock Sl. (St 4b)	1990	1994	66	2.2	9.40	3.34	1.26
	mg/L	Central and Southern Delta	26	Rock Sl. @ Old R.	1986	1994	126	1.1	9.20	3.32	0.99
	mg/L	Central and Southern Delta	27	Middle R. @ Bacon Is. Br.	1990	1994	99	2.3	11.30	4.26	1.44
	mg/L	Central and Southern Delta	28	Santa Fe-Bacon Is. Cut nr Old R.	1990	1994	61	2.4	30.00	4.01	2.03
	mg/L	Central and Southern Delta	29	Woodward/N. Victoria Canal nr Old R.	1990	1994	60	2.4	8.10	3.85	1.21
	mg/L	Central and Southern Delta	30	Middle R. @ Borden Hwy	1986	1996	796	2.3	16.10	4.87	1.33
	mg/L	Central and Southern Delta	31	Old R. nr Byron (St 9)	1990	1996	106	2.3	11.00	3.80	1.49
	mg/L	Central and Southern Delta	32	North Canal nr Old R.	1990	1994	62	2.4	8.10	4.07	1.09
	mg/L	Central and Southern Delta	33	Middle R. @ Mowry Br.	1990	1994	26	2.6	10.3	3.92	1.41
	mg/L	Central and Southern Delta	34	Clifton Court Intake	1986	1994	99	2.1	8.6	3.81	0.92
	mg/L	Central and Southern Delta	35	West Canal @ Clifton Court FB Intake	1990	1994	68	2.3	10.00	4.13	1.30
	mg/L	Central and Southern Delta	36	Old R. 6/10 mile below DMC intake	1990	1994	55	2.5	9.60	4.10	0.82
	mg/L	Central and Southern Delta	37	Delta PP Headworks	1986	1996	422	1.6	10.50	3.65	1.07
	mg/L	Central and Southern Delta	38	DMC Intake @ Lindemann Rd	1986	1996	188	1.9	11.00	3.92	1.02
	mg/L	Central and Southern Delta	39	Grant Line/Fabian/Bell Canals nr Old R.	1990	1994	57	2.6	10.00	3.94	0.91
	mg/L	Central and Southern Delta	40	Old R. U/S from DMC Intake	1990	1994	60	2.4	10.00	3.94	0.91
	mg/L	Central and Southern Delta	41	Grant Line Can @ Tracy Rd Br.	1990	1994	23	2.6	10.80	4.14	1.48
	mg/L	Central and Southern Delta	42	Old R. nr Tracy	1990	1994	26	2.8	10.40	4.36	1.26
	mg/L	Central and Southern Delta	43	San Joaquin R. @ Mossdale Br.	1990	1996	59	2.1	10.60	3.58	1.29
	mg/L	Central and Southern Delta	44	San Joaquin R. nr Vernalis - DWR	1986	1996	135	1.4	11.40	3.81	1.25
	mg/L	North Bay	8	Barker Sl. @ North Bay PP	1988	1996	204	2.8	23.50	5.06	2.60
	mg/L	Northern Delta	6	Sacramento R. @ Freeport Marina - USGS	1973	1995	14	1.4	4.9	3.01	1.06
	mg/L	Northern Delta	9	Delta Cross Channel nr Walnut Grove	1990	1994	22	1.4	6.90	2.25	0.92
	mg/L	Northern Delta	10	Georgiana Sl. @ Walnut Grove Bridge	1990	1994	23	1.5	4.90	2.27	0.64
	mg/L	Northern Delta	11	Sacramento R. @ Rio Vista Bridge	1988	1994	129	1.4	6.90	2.51	0.89
	mg/L	Northern Delta	12	Mokelumne R. below Georgiana Sl.	1990	1994	24	1.4	6.00	2.20	0.77
	mg/L	Northern Delta	45	Sacramento R. @ Greenes Landing	1986	1996	1232	1.4	13.60	2.47	0.86
	mg/L	Western Delta	17	Sacramento R. @ Mallard Is.	1986	1996	171	0.8	12.10	2.77	1.04

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TEMPERATURE

Form	Unit	Area	Station Number	Station Name	Record Period Start	Record Period End	Count	Min	Max	Mean	Standard Deviation
	°C	Central and Southern Delta	13	Little Potato Sl. @ Terminous	1989	1992	9	7.1	23.80	17.91	4.02
	°C	Central and Southern Delta	19	San Joaquin River @ Antioch	1994	1996	8	11.1	23.30	16.94	5.09
	°C	Central and Southern Delta	20	San Joaquin R. @ Jersey Point	1990	1995	72	6	23.10	17.48	4.94
	°C	Central and Southern Delta	21	Little Connection Sl. @ Empire Tract	1990	1996	1247	1.5	28.90	14.77	5.37
	°C	Central and Southern Delta	22	Middle R. nr Latham Sl.	1985	1996	820	3.4	26.60	16.35	5.45
	°C	Central and Southern Delta	23	Connection Sl. @ Mandeville Is. Bridge	1983	1994	137	6.5	27.00	17.67	5.20
	°C	Central and Southern Delta	24	Contra Costa PP no 1	1990	1996	90	6.6	27	18.16	4.51
	°C	Central and Southern Delta	25	Old R. N/O Rock Sl. (St 4b)	1989	1994	55	5.4	26.3	19.88	5.21
	°C	Central and Southern Delta	26	Rock Sl. @ Old R.	1989	1994	29	6.7	25.90	18.41	6.71
	°C	Central and Southern Delta	27	Middle R. @ Bacon Is. Br.	1985	1994	86	6.9	25.10	17.27	5.36
	°C	Central and Southern Delta	28	Santa Re-Bacon Is. Cut nr Old R.	1989	1996	104	5.3	26.00	19.20	5.86
	°C	Central and Southern Delta	29	Woodward/N. Victoria Canal nr Old R.	1989	1994	61	5.4	31.90	19.60	6.16
	°C	Central and Southern Delta	30	Middle R. @ Borden Hwy	1988	1994	49	6.6	25.20	18.09	5.80
	°C	Central and Southern Delta	31	Old R. nr Byron (St 9)	1989	1994	55	5.5	25.70	19.90	4.02
	°C	Central and Southern Delta	32	North Canal nr Old R.	1990	1994	23	7.1	25.50	18.50	5.39
	°C	Central and Southern Delta	33	Middle R. @ Mowry Br.	1985	1996	181	7.4	25.50	17.39	4.42
	°C	Central and Southern Delta	34	Clifton Court Intake	1988	1996	209	6.3	28.20	18.17	4.71
	°C	Central and Southern Delta	35	West Canal @ Clifton Court FB Intake	1989	1996	229	5.6	26.40	16.60	4.78
	°C	Central and Southern Delta	36	Old R. 6/10 mile below DMC intake	1989	1994	94	7.2	28.00	19.42	5.37
	°C	Central and Southern Delta	37	Delta PP Headworks	1989	1994	22	7.8	24.60	18.45	4.61
	°C	Central and Southern Delta	38	DMC Intake @ Lindemann Rd	1990	1996	277	6.4	26.20	17.34	5.20
	°C	Central and Southern Delta	39	Grant Line/Fabian/Bell Canals nr Old R.	1989	1994	51	5.4	26.30	19.95	5.27
	°C	Central and Southern Delta	40	Old R. U/S from DMC Intake	1989	1994	55	5.5	26.30	20.33	4.30
	°C	Central and Southern Delta	41	Grant Line Can @ Tracy Rd. Br.	1989	1994	25	7.5	27.10	18.77	6.69
	°C	Central and Southern Delta	42	Old R. nr Tracy	1990	1994	49	5.4	26.10	19.88	5.02
	°C	Central and Southern Delta	43	San Joaquin R. @ Mossdale Br.	1989	1996	63	6.5	26.30	17.64	5.08
	°C	Central and Southern Delta	44	San Joaquin R. nr Vernalis	1989	1994	60	5.1	24.90	18.78	5.22
	°C	North Bay	8	Barker Sl. @ North Bay PP	1983	1996	510	4.7	30.50	17.92	5.11
	°C	Northern Delta	6	Sacramento River @ Freeport Marina - CMP	1992	1996	45	6.2	23.1	14.49	
	°C	Northern Delta	6	Sacramento River @ Freeport Marina - USG	1973	1995	940	6	25.00	15.11	4.99
	°C	Northern Delta	7	Sacramento River Mile 44	1992	1996	53	7.16	22.40	14.43	
	°C	Northern Delta	9	Delta Cross Channel nr Walnut Grove	1989	1992	10	6.5	23.80	18.37	3.84
	°C	Northern Delta	10	Georgiana Sl. @ Walnut Grove Bridge	1989	1994	23	7.7	24.90	17.67	5.17
	°C	Northern Delta	11	Sacramento R. @ Rio Vista Br.	1989	1994	55	5.3	25.50	19.60	4.10
	°C	Northern Delta	12	Mokelumne R. below Georgiana Sl.	1989	1994	27	6.8	26.20	18.79	6.10
	°C	Northern Delta	18	Sacramento River @ Collinsville	1994	1996	8	10.1	21.50	15.48	5.18
	°C	Northern Delta	18	Sacramento R. @ Mallard Is.	1989	1994	118	7.7	26.20	17.54	4.79
	°C	Northern Delta	45	Sacramento R. @ Greenes Landing	1983	1994	160	5.1	26	17.98	5.42
	°C	Western Delta	14	Pacheco Creek (outside area map)	1994	1996	8	11	21.30	16.00	4.13
	°C	Western Delta	15	Grizzly Bay (outside map area)	1994	1996	8	10.6	21.50	15.33	4.49
	°C	Western Delta	16	Honker Bay	1994	1996	6	10.5	22.00	15.80	5.26

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TURBIDITY

Form	Unit	Area	Station Number	Station Name	Record Period Start	Record Period End	Count	Min	Max	Mean	Standard Deviation
Hach.	mg/L	Central and Southern Delta	13	Little Potato Sl. @ Terminous	1988	1994	50	3	48.00	8.68	4.76
Field	mg/L	Central and Southern Delta	13	Little Potato Sl. @ Terminous	1989	1992	12	2	10.00	6.17	2.19
Hach.	mg/L	Central and Southern Delta	20	San Joaquin R. @ Jersey Point	1990	1994	79	3	76.00	11.99	8.10
Field	mg/L	Central and Southern Delta	20	San Joaquin R. @ Jersey Point	1990	1995	79	3	76.00	11.99	8.10
Hach.	mg/L	Central and Southern Delta	21	Little Connection Sl. @ Empire Tr.	1985	1994	86	3	38.00	6.95	3.81
Field	mg/L	Central and Southern Delta	21	Little Connection Sl. @ Empire Tract	1990	1996	206	1	100	13.68	12.64
Hach.	mg/L	Central and Southern Delta	22	Middle R. nr L@ham Sl.	1989	1992	12	2	10	6.17	2.19
Field	mg/L	Central and Southern Delta	22	Middle R. nr Latham Sl.	1985	1996	169	3	36.00	9.23	3.57
Hach.	mg/L	Central and Southern Delta	23	Connection Sl. @ Mandeville Is. Bridge	1989	1992	12	2	10.00	6.33	2.07
Field	mg/L	Central and Southern Delta	23	Connection Sl. @ Mandeville Is. Bridge	1983	1994	139	2	28.00	11.14	4.75
Hach.	mg/L	Central and Southern Delta	24	Contra Costa PP #01	1990	1996	75	0	21.00	7.23	3.34
Field	mg/L	Central and Southern Delta	24	Contra Costa PP no 1	1990	1996	81	2	21.00	7.82	3.56
Hach.	mg/L	Central and Southern Delta	25	Old R. N/O Rock Sl. (St 4b)	1989	1994	66	2	23.00	6.44	3.26
Field	mg/L	Central and Southern Delta	25	Old R. N/O Rock Sl. (St 4b)	1989	1994	64	3	14.00	6.70	2.21
Hach.	mg/L	Central and Southern Delta	26	Rock Sl. @ Old R.	1983	1994	169	2	23.00	8.66	3.96
Field	mg/L	Central and Southern Delta	26	Rock Sl. @ Old R.	1989	1994	27	6	60.00	17.93	7.64
Hach.	mg/L	Central and Southern Delta	27	Middle R. @ Bacon Is. Br.	1989	1994	100	2	21.00	6.47	2.70
Field	mg/L	Central and Southern Delta	27	Middle R. @ Bacon Is. Br.	1985	1994	86	3	38.00	6.95	3.81
Hach.	mg/L	Central and Southern Delta	28	Santa Fe-Bacon Is. Cut nr Old R.	1989	1994	62	2	14.00	6.03	1.47
Field	mg/L	Central and Southern Delta	28	Santa Re-Bacon Is. Cut nr Old R.	1989	1996	94	2	76.00	9.73	6.15
Hach.	mg/L	Central and Southern Delta	29	Woodward/N. Victoria Canal nr Old R.	1989	1994	62	0	13.00	6.16	1.62
Field	mg/L	Central and Southern Delta	29	Woodward/N. Victoria Canal nr Old R.	1989	1994	69	3	25.00	9.97	4.30
Hach.	mg/L	Central and Southern Delta	30	Middle R. @ Borden Hwy	1985	1996	170	3	36.00	9.12	3.56
Field	mg/L	Central and Southern Delta	30	Middle R. @ Borden Hwy	1988	1994	50	3	48.00	8.68	4.76
Hach.	mg/L	Central and Southern Delta	31	Old R. nr Byron (St 9)	1989	1996	94	2	28.00	8.56	3.81
Field	mg/L	Central and Southern Delta	31	Old R. nr Byron (St 9)	1989	1994	61	2	13.00	6.26	1.57
Hach.	mg/L	Central and Southern Delta	32	North Canal nr Old R.	1989	1994	64	3	14	6.70	2.21
Field	mg/L	Central and Southern Delta	32	North Canal nr Old R.	1990	1994	24	3	44	8.96	5.36
Hach.	mg/L	Central and Southern Delta	33	Middle R. @ Mowry Br.	1989	1994	27	4	44	18.74	9.13
Field	mg/L	Central and Southern Delta	33	Middle R. @ Mowry Br.	1985	1996	180	4	84	20.59	10.29
Hach.	mg/L	Central and Southern Delta	34	Clifton Court Intake	1983	1994	139	2	28	11.14	4.75
Field	mg/L	Central and Southern Delta	34	Clifton Court Intake	1988	1996	123	9	180	30.75	19.61
Hach.	mg/L	Central and Southern Delta	35	West Canal @ Clifton Court FB Intake	1989	1994	69	3	25	9.97	4.30
Field	mg/L	Central and Southern Delta	35	West Canal @ Clifton Court FB Intake	1989	1996	161	3	160	22.66	14.55
Hach.	mg/L	Central and Southern Delta	36	Old R. 6/10 mile below DMC intake	1990	1994	56	3	30	10.54	4.70
Field	mg/L	Central and Southern Delta	36	Old R. 6/10 mile below DMC intake	1989	1994	100	2	21	6.47	2.70
Hach.	mg/L	Central and Southern Delta	37	Delta PP Headworks	1983	1996	225	2	37	10.16	6.21
Field	mg/L	Central and Southern Delta	37	Delta PP Headworks	1989	1994	23	3	26	7.09	4.24
Hach.	mg/L	Central and Southern Delta	38	DMC Intake @ Lindemann Rd	1983	1996	217	3	76	14.02	6.62

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Field	mg/L	Central and Southern Delta	38	DMC Intake @ Lindemann Rd	1990	1996	224	3	305	16.27	11.72
Hach.	mg/L	Central and Southern Delta	39	Grant Line/Fabian/Bell Canals nr Old R.	1989	1994	58	3	31	11.59	5.78
Field	mg/L	Central and Southern Delta	39	Grant Line/Fabian/Bell Canals nr Old R.	1989	1994	58	3	31	11.59	5.78
Hach.	mg/L	Central and Southern Delta	40	Old R. U/S from DMC Intake	1989	1994	62	4	34	11.00	4.26
Field	mg/L	Central and Southern Delta	40	Old R. U/S from DMC Intake	1989	1994	62	4	34	11.00	4.26
Hach.	mg/L	Central and Southern Delta	41	Grant Line Can @ Tracy Rd Br.	1989	1994	24	8	52	17.29	8.00
Field	mg/L	Central and Southern Delta	41	Grant Line Can @ Tracy Rd. Br.	1989	1994	24	8	52	17.29	8.00
Hach.	mg/L	Central and Southern Delta	42	Old R. nr Tracy	1989	1994	27	6	60	17.93	7.64
Field	mg/L	Central and Southern Delta	42	Old R. nr Tracy	1990	1994	56	3	30	10.54	4.70
Hach.	mg/L	Central and Southern Delta	43	San Joaquin R. @ Mossdale Br.	1989	1996	54	4	200	22.17	16.37
Field	mg/L	Central and Southern Delta	43	San Joaquin R. @ Mossdale Br.	1989	1996	56	4	248	27.59	22.96
Hach.	mg/L	Central and Southern Delta	44	San Joaquin R. nr Vernalis - DWR	1983	1996	160	3	160	21.71	14.14
Field	mg/L	Central and Southern Delta	44	San Joaquin R. nr Vernalis	1989	1994	66	2	23	6.44	3.26
Hach.	mg/L	North Bay	8	Barker Sl. @ North Bay PP	1988	1996	105	9	180.00	27.28	22.10
Field	mg/L	North Bay	8	Barker Sl. @ North Bay PP	1983	1996	232	2	37.00	10.27	6.35
	jtu	Northern Delta	6	Sacramento R. @ Freeport Marina - USGS	1973	1995	22	1	70	17.18	15.22
	ntu	Northern Delta	6	Sacramento R. @ Freeport Marina - USGS	1973	1995	597	1	280.00	21.06	27.77
Hach.	mg/L	Northern Delta	9	Delta Cross Channel nr Walnut Grove	1989	1994	23	3	26.00	7.09	4.24
Field	mg/L	Northern Delta	9	Delta Cross Channel nr Walnut Grove	1989	1992	12	2	10.00	6.33	2.07
Hach.	mg/L	Northern Delta	10	Georgiana Sl. @ Walnut Grove Bridge	1989	1994	24	3	30.00	7.25	4.29
Field	mg/L	Northern Delta	10	Georgiana Sl. @ Walnut Grove Bridge	1989	1994	24	3	30.00	7.25	4.29
Hach.	mg/L	Northern Delta	11	Sacramento R. @ Rio Vista Bridge	1988	1994	131	0	116.00	14.35	10.94
Field	mg/L	Northern Delta	11	Sacramento R. @ Rio Vista Br.	1989	1994	62	2	14.00	6.03	1.47
Hach.	mg/L	Northern Delta	12	Mokelumne R. below Georgiana Sl.	1990	1994	24	3	44.00	8.96	5.36
Field	mg/L	Northern Delta	12	Mokelumne R. below Georgiana Sl.	1989	1994	27	4	44.00	18.74	9.13
Field	mg/L	Northern Delta	18	Sacramento R. @ Mallard Is.	1989	1994	126	4	116.00	14.51	12.03
Hach.	mg/L	Northern Delta	45	Sacramento R. @ Greenes Landing	1983	1996	191	1	100	12.04	11.87
Field	mg/L	Northern Delta	45	Sacramento R. @ Greenes Landing	1983	1994	169	2	23.00	8.66	3.96
Hach.	mg/L	Western Delta	17	Sacramento R. @ Mallard Is.	1985	1996	172	4	84.00	19.69	9.92

C-031452

DISSOLVED OXYGEN

Form	Unit	Area	Station Number	Station Name	Record Period Start	Record Period End	Count	Min	Max	Mean	Standard Deviation
	mg/L	Central and Southern Delta	13	Little Potato Sl. @ Terminous	1989	1992	6	7.2	10.70	8.45	0.91
	mg/L	Central and Southern Delta	19	San Joaquin River @ Antioch	1994	1996	5	8	9.90	9.13	0.76
	mg/L	Central and Southern Delta	20	San Joaquin R. @ Jersey Point	1990	1995	67	6.3	11.90	8.71	1.09
	mg/L	Central and Southern Delta	21	Little Connection Sl. @ Empire Tract	1990	1996	226	5.6	13.10	9.30	1.39
	mg/L	Central and Southern Delta	22	Middle R. nr Latham Sl.	1985	1996	170	4.6	12.10	8.58	1.36
	mg/L	Central and Southern Delta	23	Connection Sl. @ Mandeville Is. Bridge	1983	1994	132	4.8	12.60	8.70	1.44
	mg/L	Central and Southern Delta	24	Contra Costa PP no 1	1990	1996	87	6.38	13.2	8.74	1.37
	mg/L	Central and Southern Delta	25	Old R. N/O Rock Sl. (St 4b)	1989	1994	49	6	11.6	7.87	1.21
	mg/L	Central and Southern Delta	26	Rock Sl. @ Old R.	1989	1994	29	5.9	11.10	8.26	1.37
	mg/L	Central and Southern Delta	27	Middle R. @ Bacon Is. Br.	1985	1994	84	5.1	11.30	8.62	1.13
	mg/L	Central and Southern Delta	28	Santa Re-Bacon Is. Cut nr Old R.	1989	1996	96	6.4	20.90	8.44	1.51
	mg/L	Central and Southern Delta	29	Woodward/N. Victoria Canal nr Old R.	1989	1994	53	6.2	11.80	8.02	1.25
	mg/L	Central and Southern Delta	30	Middle R. @ Borden Hwy	1988	1994	42	6.8	11.80	8.68	1.09
	mg/L	Central and Southern Delta	31	Old R. nr Byron (St 9)	1989	1994	48	6.3	11.60	7.98	1.12
	mg/L	Central and Southern Delta	32	North Canal nr Old R.	1990	1994	22	6.6	10.90	8.55	1.02
	mg/L	Central and Southern Delta	33	Middle R. @ Mowry Br.	1985	1996	175	5	12.60	9.01	1.24
	mg/L	Central and Southern Delta	34	Clifton Court Intake	1988	1996	126	3.7	12.20	8.22	1.36
	mg/L	Central and Southern Delta	35	West Canal @ Clifton Court FB Intake	1989	1996	221	1.9	88.70	8.99	1.99
	mg/L	Central and Southern Delta	36	Old R. 6/10 mile below DMC intake	1989	1994	89	4.5	11.30	8.19	1.29
	mg/L	Central and Southern Delta	37	Delta PP Headworks	1989	1994	21	6.5	10.40	8.32	0.97
	mg/L	Central and Southern Delta	38	DMC Intake @ Lindemann Rd	1990	1996	263	4.6	12.40	8.63	1.36
	mg/L	Central and Southern Delta	39	Grant Line/Fabian/Bell Canals nr Old R.	1989	1994	45	5.9	13.00	7.90	1.47
	mg/L	Central and Southern Delta	40	Old R. U/S from DMC Intake	1989	1994	48	5.4	12.00	7.90	1.27
	mg/L	Central and Southern Delta	41	Grant Line Can @ Tracy Rd. Br.	1989	1994	25	5.7	10.90	8.34	1.46
	mg/L	Central and Southern Delta	42	Old R. nr Tracy	1990	1994	44	6.3	11.60	7.88	1.33
	mg/L	Central and Southern Delta	43	San Joaquin R. @ Mossdale Br.	1989	1996	61	6.9	11.50	8.86	1.05
	mg/L	Central and Southern Delta	44	San Joaquin R. nr Vernalis	1989	1994	54	6.7	12.10	8.41	1.19
	mg/L	North Bay	8	Barker Sl. @ North Bay PP	1983	1996	265	4.7	12.60	8.87	1.36
	mg/L	Northern Delta	6	Sacramento River @ Freeport Marina - CMP	1992	1996	42	7.9	11.87		
	mg/L	Northern Delta	6	Sacramento River @ Freeport Marina - USG.	1973	1995	284	7.2	13.50	9.66	1.14
	mg/L	Northern Delta	7	Sacramento River Mile 44	1992	1996	51	7.59	11.80	9.64	
	mg/L	Northern Delta	9	Delta Cross Channel nr Walnut Grove	1989	1992	6	7.4	9.80	8.48	0.72
	mg/L	Northern Delta	10	Georgiana Sl. @ Walnut Grove Bridge	1989	1994	22	5.4	10.80	8.23	0.90
	mg/L	Northern Delta	11	Sacramento R. @ Rio Vista Br.	1989	1994	49	6	11.80	8.09	1.11
	mg/L	Northern Delta	12	Mokelumne R. below Georgiana Sl.	1989	1994	27	6.3	12.90	8.92	1.10
	mg/L	Northern Delta	18	Sacramento River @ Collinsville	1994	1996	5	8	10.00	9.18	0.92
	mg/L	Northern Delta	18	Sacramento R. @ Mallard Is.	1989	1994	111	6.3	12.40	8.82	1.33
	mg/L	Northern Delta	45	Sacramento R. @ Greenes Landing	1983	1994	151	6.1	13.2	8.81	1.39
	mg/L	Western Delta	14	Pacheco Creek (outside area map)	1994	1996	5	7.8	11.10	9.61	1.22
	mg/L	Western Delta	15	Grizzly Bay (outside map area)	1994	1996	5	8.6	10.50	9.68	0.79
	mg/L	Western Delta	16	Honker Bay	1994	1996	3	8.1	10.00	9.33	1.07

C-031452

3

AMMONIA

Form	Unit	Area	Station Number	Station Name	Record Period Start	Record Period End	Count	Min	Max	Mean	Standard Deviation
	uM	Central and Southern Delta	19	San Joaquin R. @ Antioch	1994	1996	8	1.90	9.70	4.30	2.93
Total	mg/L	Northern Delta	6	Sacramento R. @ Freeport Marina - USGS	1973	1995	72	0.01	0.49	0.09	0.09
	uM	Northern Delta	18	Sacramento R. @ Collinsville	1994	1996	8	2.17	13.70	5.35	4.03
Dissolved	mg/L	Northern Delta	45	Sacramento R. @ Greenes Landing	1991	1996	12	0.00	0.47	0.21	0.04
	uM	Western Delta	14	Pacheco Creek (outside area map)	1994	1996	8	2.10	10.20	5.41	3.01
	uM	Western Delta	15	Grizzly Bay (outside map area)	1994	1996	8	0.90	9.49	4.49	3.41
	uM	Western Delta	16	Honker Bay	1994	1996	6	1.60	9.50	4.12	3.37

C-031453

NITRATE

Form	Unit	Area	Station Number	Station Name	Record Period Start	Record Period End	Count	Min	Max	Mean	Standard Deviation
Nitrogen, Dissolved	mg/L	Central and Southern Delta	13	Little Potato Sl. @ Terminous	1990	1992	13	1.3	5.10	2.84	0.94
	uM	Central and Southern Delta	19	San Joaquin R. @ Antioch	1990	1991	8	12.1	40.60	25.45	11.05
Nitrogen, Dissolved	mg/L	Central and Southern Delta	21	Little Connection Sl. @ Empire Tr.	1990	1992	13	1.3	7.30	3.06	1.29
Nitrogen, Dissolved	mg/L	Central and Southern Delta	24	Contra Costa PP #01	1991	1996	16	0.08	10.00	2.30	0.74
Nitrogen, Dissolved	mg/L	Central and Southern Delta	27	Middle R. @ Bacon Is. Br.	1990	1992	22	1.2	8.30	3.63	1.64
Nitrogen, Dissolved	mg/L	Central and Southern Delta	30	Middle R. @ Borden Hwy	1990	1992	27	1.4	7.20	3.56	1.49
Nitrogen, Dissolved	mg/L	Central and Southern Delta	31	Old R. nr Byron (St 9)	1990	1996	15	0.25	4.10	1.80	0.55
Nitrogen, Dissolved	mg/L	Central and Southern Delta	33	Middle R. @ Mowry Br.	1990	1992	11	3.7	9.9	5.88	1.91
Nitrogen, Dissolved	mg/L	Central and Southern Delta	37	Delta PP Headworks	1990	1996	38	0.23	7.9	3.11	1.10
Nitrogen, Dissolved	mg/L	Central and Southern Delta	38	DMC Intake @ Lindemann Rd	1990	1996	37	0.57	9.60	3.80	1.41
Nitrogen, Dissolved	mg/L	Central and Southern Delta	41	Grant Line Can @ Tracy Rd Br.	1990	1992	12	1.9	17.00	9.04	3.75
Nitrogen, Dissolved	mg/L	Central and Southern Delta	42	Old R. nr Tracy	1990	1992	15	0.8	18.00	9.73	5.56
Nitrogen, Dissolved	mg/L	Central and Southern Delta	43	San Joaquin R. @ Mossdale Br.	1990	1996	17	0	15.00	7.17	3.26
Nitrogen, Dissolved	mg/L	Central and Southern Delta	44	San Joaquin R. nr Vernalis - DWR	1990	1992	33	2.8	16.00	8.52	2.13
Nitrogen, Dissolved	mg/L	North Bay	8	Barker Sl. @ North Bay PP	1990	1996	32	0.06	8.80	2.31	1.10
Total Nitrogen	mg/L	Northern Delta	6	Sacramento R. @ Freeport Marina - USGS	1973	1995	167	0.15	38	0.84	2.91
Nitrate and Nitrite, Dissolved	mg/L	Northern Delta	6	Sacramento R. @ Freeport Marina - USGS	1973	1995	116	0.04	0.47	0.15	0.08
Nitrogen, Dissolved	mg/L	Northern Delta	9	Delta Cross Channel nr Walnut Grove	1990	1992	11	1	4.90	2.47	1.04
Nitrogen, Dissolved	mg/L	Northern Delta	10	Georgiana Sl. @ Walnut Grove Bridge	1990	1992	12	1	5.30	2.49	1.06
Nitrogen, Dissolved	mg/L	Northern Delta	11	Sacramento R. @ Rio Vista Bridge	1990	1992	26	1.1	5.60	2.97	0.94
Nitrogen, Dissolved	mg/L	Northern Delta	12	Mokelumne R. below Georgiana Sl.	1990	1992	11	1.3	3.00	2.31	0.41
	uM	Northern Delta	18	Sacramento R. @ Collinsville	1994	1996	8	8.7	35.41	21.94	9.65
Nitrogen, Dissolved	mg/L	Northern Delta	45	Sacramento R. @ Greenes Landing	1990	1992	32	0.5	7.70	3.00	1.43
	uM	Western Delta	14	Pacheco Creek (outside area map)	1994	1996	8	11.8	34.80	26.04	8.92
	uM	Western Delta	15	Grizzly Bay (outside map area)	1990	1991	8	10.9	34.40	25.33	8.43
	uM	Western Delta	16	Honker Bay	1994	1996	6	8.5	34.20	22.05	9.40
Nitrogen, Dissolved	mg/L	Western Delta	17	Sacramento R. @ Mallard Is.	1990	1992	25	1.2	4.40	2.36	0.74

PHOSPHATE

Form	Unit	Area	Station Number	Station Name	Record Period Start	Record Period End	Count	Min	Max	Mean	Standard Deviation
	uM	Central and Southern Delta	19	San Joaquin River @ Antioch	1994	1996	8	1.8	3.02	2.33	0.43
Total Phosphorus	mg/L	Northern Delta	6	Sacramento River @ Freeport Marina - USG.	1973	1995	192	0.01	0.54	0.10	0.07
	uM	Northern Delta	18	Sacramento River @ Collinsville	1994	1996	8	1.1	3.40	2.27	0.77
	uM	Western Delta	14	Pacheco Creek (outside area map)	1994	1996	8	1.6	12.80	3.96	3.67
	uM	Western Delta	15	Grizzly Bay (outside map area)	1994	1996	8	1.6	10.80	3.70	2.98
	uM	Western Delta	16	Honker Bay	1994	1996	6	1.4	7.20	3.02	2.17

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pH

Form	Unit	Area	Station Number	Station Name	Record Period Start	Record Period End	Count	Min	Max	Mean	Standard Deviation
		Central and Southern Delta	13	Little Potato Sl. @ Terminous	1989	1992	8	7.1	8.10	7.54	0.25
		Central and Southern Delta	19	San Joaquin River @ Antioch	1994	1996	8	7.5	8.00	7.71	0.16
		Central and Southern Delta	20	San Joaquin R. @ Jersey Point	1990	1995	71	7	8.80	7.66	0.35
		Central and Southern Delta	21	Little Connection Sl. @ Empire Tract	1990	1996	235	6.1	118.00	7.91	2.65
		Central and Southern Delta	22	Middle R. nr Latham Sl.	1985	1996	174	6.5	8.70	7.49	0.31
		Central and Southern Delta	23	Connection Sl. @ Mandeville Is. Bridge	1983	1994	132	6.8	8.3	7.53	0.21
		Central and Southern Delta	24	Contra Costa PP no 1	1990	1996	90	6.3	8.5	7.72	0.35
		Central and Southern Delta	25	Old R. N/O Rock Sl. (St 4b)	1989	1994	53	7	8.20	7.59	0.23
		Central and Southern Delta	26	Rock Sl. @ Old R.	1989	1994	26	6.7	8.30	7.53	0.36
		Central and Southern Delta	27	Middle R. @ Bacon Is. Br.	1985	1994	83	6.4	9.10	7.48	0.30
		Central and Southern Delta	28	Santa Re-Bacon Is. Cut nr Old R.	1989	1996	100	6.4	8.50	7.51	0.32
		Central and Southern Delta	29	Woodward/N. Victoria Canal nr Old R.	1989	1994	58	7	8.30	7.62	0.22
		Central and Southern Delta	30	Middle R. @ Borden Hwy	1988	1994	47	6.3	8.30	7.60	0.26
		Central and Southern Delta	31	Old R. nr Byron (St 9)	1989	1994	52	7	8.20	7.61	0.26
		Central and Southern Delta	32	North Canal nr Old R.	1990	1994	22	6.2	8.50	7.59	0.38
		Central and Southern Delta	33	Middle R. @ Mowry Br.	1985	1996	183	6.3	9.50	7.62	0.29
		Central and Southern Delta	34	Clifton Court Intake	1988	1996	130	5.8	20.20	7.57	0.66
		Central and Southern Delta	35	West Canal @ Clifton Court FB Intake	1989	1996	226	6.2	9.50	7.57	0.31
		Central and Southern Delta	36	Old R. 6/10 mile below DMC intake	1989	1994	89	6.7	8.50	7.51	0.36
		Central and Southern Delta	37	Delta PP Headworks	1989	1994	22	6.1	8.60	7.46	0.44
		Central and Southern Delta	38	DMC Intake @ Lindemann Rd	1990	1996	261	6.1	8.80	7.54	0.25
		Central and Southern Delta	39	Grant Line/Fabian/Bell Canals nr Old R.	1989	1994	48	7	8.30	7.66	0.30
		Central and Southern Delta	40	Old R. U/S from DMC Intake	1989	1994	51	7	8.40	7.67	0.27
		Central and Southern Delta	41	Grant Line Can @ Tracy Rd. Br.	1989	1994	23	6.6	9.20	7.65	0.48
		Central and Southern Delta	42	Old R. nr Tracy	1990	1994	47	7	8.20	7.61	0.26
		Central and Southern Delta	43	San Joaquin R. @ Mossdale Br.	1989	1996	62	6.7	8.80	7.55	0.43
		Central and Southern Delta	44	San Joaquin R. nr Vernalis	1989	1994	57	6.9	8.8	7.72	0.34
		North Bay	8	Barker Sl. @ North Bay PP	1983	1996	281	6.5	8.60	7.58	0.29
field		Northern Delta	6	Sacramento River @ Freeport Marina - USGS	1973	1995	338	6.5	8.2	7.60	0.30
lab		Northern Delta	6	Sacramento River @ Freeport Marina - USGS	1973	1995	110	6.9	8.60	7.90	0.26
		Northern Delta	6	Sacramento River @ Freeport Marina - CMP	1992	1996	49	5.6	8.79	7.53	
		Northern Delta	7	Sacramento River Mile 44	1992	1996	56	6.14	8.52	7.36	
		Northern Delta	9	Delta Cross Channel nr Walnut Grove	1989	1992	9	7.2	8.20	7.62	0.23
		Northern Delta	10	Georgiana Sl. @ Walnut Grove Bridge	1989	1994	23	6.3	8.20	7.43	0.37
		Northern Delta	11	Sacramento R. @ Rio Vista Br.	1989	1994	52	7	8.30	7.67	0.22
		Northern Delta	12	Mokelumne R. below Georgiana Sl.	1989	1994	25	7	8.80	7.73	0.35
		Northern Delta	18	Sacramento River @ Collinsville	1994	1996	8	7.5	8.00	7.75	0.16
		Northern Delta	18	Sacramento R. @ Mallard Is.	1989	1994	117	6.1	8.80	7.58	0.29
		Northern Delta	45	Sacramento R. @ Greenes Landing	1983	1994	156	6.7	8.8	7.58	0.27
		Western Delta	14	Pacheco Creek (outside area map)	1994	1996	8	7.7	8.20	7.89	0.16
		Western Delta	15	Grizzly Bay (outside map area)	1994	1996	8	7.7	8.00	7.85	0.12
		Western Delta	16	Honker Bay	1994	1996	6	7.5	8.00	7.78	0.18

C-031456

ALKALINITY

Form	Unit	Area	Station Number	Station Name	Record Period Start	Record Period End	Count	Min	Max	Mean	Standard Deviation
as CaCO3	mg/L	Central and Southern Delta	13	Little Potato Sl. @ Terminous	1988	1994	45	42.00	82.00	59.27	9.28
as CaCO3	mg/L	Central and Southern Delta	20	San Joaquin R. @ Jersey Point	1990	1994	26	48.00	85.00	65.38	6.94
as CaCO3	mg/L	Central and Southern Delta	21	Little Connection Sl. @ Empire Tr.	1989	1994	26	38.00	90.00	60.50	9.02
as CaCO3	mg/L	Central and Southern Delta	22	Middle R. nr Latham Sl.	1989	1992	12	55.00	76.00	62.83	6.56
as CaCO3	mg/L	Central and Southern Delta	24	Contra Costa PP #01	1991	1996	84	38.00	119.00	67.58	12.01
as CaCO3	mg/L	Central and Southern Delta	25	Old R. N/O Rock Sl. (St 4b)	1988	1994	24	46.00	81.00	64.71	8.36
as CaCO3	mg/L	Central and Southern Delta	26	Rock Sl. @ Old R.	1986	1994	41	46.00	89.00	66.20	7.68
as CaCO3	mg/L	Central and Southern Delta	27	Middle R. @ Bacon Is. Br.	1989	1994	61	39.00	87.00	67.11	8.22
as CaCO3	mg/L	Central and Southern Delta	28	Santa Fe-Bacon Is. Cut nr Old R.	1989	1994	20	57.00	81.00	66.75	9.04
as CaCO3	mg/L	Central and Southern Delta	29	Woodward/N. Victoria Canal nr Old R.	1989	1994	20	59.00	124.00	70.00	13.17
as CaCO3	mg/L	Central and Southern Delta	30	Middle R. @ Borden Hwy	1986	1996	114	32.00	83.00	64.11	7.37
as CaCO3	mg/L	Central and Southern Delta	31	Old R. nr Byron (St 9)	1989	1996	59	32.00	83.00	58.73	7.73
as CaCO3	mg/L	Central and Southern Delta	32	North Canal nr Old R.	1989	1994	19	58.00	84.00	68.32	9.78
as CaCO3	mg/L	Central and Southern Delta	33	Middle R. @ Mowry Br.	1989	1994	28	47.00	140.00	102.29	15.69
as CaCO3	mg/L	Central and Southern Delta	34	Clifton Court Intake	1986	1994	66	39.00	107.00	71.12	9.41
as CaCO3	mg/L	Central and Southern Delta	35	West Canal @ Clifton Court FB Intake	1989	1994	23	49.00	101.00	68.74	8.78
as CaCO3	mg/L	Central and Southern Delta	36	Old R. 6/10 mile below DMC intake	1990	1994	16	60.00	105.00	77.00	10.68
as CaCO3	mg/L	Central and Southern Delta	36	Old R. U/S from DMC Intake	1989	1994	21	59.00	104.00	79.57	12.29
as CaCO3	mg/L	Central and Southern Delta	37	DMC Intake @ Lindemann Rd	1990	1996	105	33	130	73.69	15.42
as CaCO3	mg/L	Central and Southern Delta	38	Delta PP Headworks	1990	1996	107	8.2	96	66.70	9.94
as CaCO3	mg/L	Central and Southern Delta	39	Grant Line/Fabian/Bell Canals nr Old R.	1989	1994	19	60.00	118.00	86.68	12.36
as CaCO3	mg/L	Central and Southern Delta	41	Grant Line Can @ Tracy Rd Br.	1989	1994	26	46.00	154.00	114.73	16.33
as CaCO3	mg/L	Central and Southern Delta	42	Old R. nr Tracy	1989	1994	30	47.00	173.00	124.20	13.35
as CaCO3	mg/L	Central and Southern Delta	43	San Joaquin R. @ Mossdale Br.	1989	1996	64	31.00	150.00	91.95	16.92
as CaCO3	mg/L	Central and Southern Delta	44	San Joaquin R. nr Vernalis - DWR	1986	1996	152	39.00	155.00	106.91	19.19
as CaCO3	mg/L	North Bay	8	Barker Sl. @ North Bay PP	1986	1994	110	48.00	150.00	96.65	19.57
fixed endpoint, unfiltered, field, as CaCO3	mg/L	Northern Delta	6	Sacramento R. @ Freeport Marina - USGS	1973	1995	3	60.00	69.00	63.67	4.73
fixed endpoint, unfiltered, lab, as CaCO3	mg/L	Northern Delta	6	Sacramento R. @ Freeport Marina - USGS	1973	1995	111	28.00	94.00	53.91	11.11
as CaCO3	mg/L	Northern Delta	9	Delta Cross Channel nr Walnut Grove	1989	1994	23	37.00	79.00	57.74	9.23
as CaCO3	mg/L	Northern Delta	10	Georgiana Sl. @ Walnut Grove Bridge	1989	1994	24	38.00	81.00	59.00	7.93
as CaCO3	mg/L	Northern Delta	11	Sacramento R. @ Rio Vista Bridge	1988	1994	83	43.00	250.00	67.04	16.84
as CaCO3	mg/L	Northern Delta	12	Mokelumne R. below Georgiana Sl.	1990	1994	24	40.00	83.00	58.50	9.91
as CaCO3	mg/L	Northern Delta	45	Sacramento R. at Greenes Landing	1986	1996	156	30.00	86.00	59.15	8.78
as CaCO3	mg/L	Western Delta	17	Sacramento R. @ Mallard Is.	1986	1996	136	37.00	105.00	65.38	8.14

C-031457

HARDNESS

Form	Unit	Area	Station Number	Station Name	Record Period Start	Record Period End	Count	Min	Max	Mean	Standard Deviation
as CaCO3	mg/L	Central and Southern Delta	13	Little Potato Sl. @ Terminous	1988	1994	44	46	84.00	61.07	10.92
	uM	Central and Southern Delta	19	San Joaquin R. @ Antioch	1994	1996	6	64	530.00	176.33	179.02
as CaCO3	mg/L	Central and Southern Delta	20	San Joaquin R. @ Jersey Point	1990	1994	78	64	477.00	168.00	48.59
as CaCO3	mg/L	Central and Southern Delta	21	Little Connection Sl. @ Empire Tr.	1990	1994	25	43	105.00	67.24	12.13
as CaCO3	mg/L	Central and Southern Delta	24	Contra Costa PP #01	1990	1996	87	43	251.00	104.61	29.32
as CaCO3	mg/L	Central and Southern Delta	25	Old R. N/O Rock Sl. (St 4b)	1989	1996	66	46	169.00	109.92	18.81
as CaCO3	mg/L	Central and Southern Delta	26	Rock Sl. @ Old R.	1986	1994	90	46	169	109.4778	19.12
as CaCO3	mg/L	Central and Southern Delta	27	Middle R. @ Bacon Is. Br.	1990	1994	99	46	140	97.66667	18.87
as CaCO3	mg/L	Central and Southern Delta	28	Santa Fe-Bacon Is. Cut nr Old R.	1990	1994	60	70	163.00	104.63	17.99
as CaCO3	mg/L	Central and Southern Delta	29	Woodward/N. Victoria Canal nr Old R.	1990	1994	60	68	166.00	104.18	20.81
as CaCO3	mg/L	Central and Southern Delta	30	Middle R. @ Borden Hwy	1986	1996	112	42	141.00	91.99	18.31
as CaCO3	mg/L	Central and Southern Delta	31	Old R. nr Byron (St 9)	1989	1994	105	42	166.00	97.30	19.08
as CaCO3	mg/L	Central and Southern Delta	32	North Canal nr Old R.	1990	1994	63	68	142.00	102.03	20.75
as CaCO3	mg/L	Central and Southern Delta	33	Middle R. @ Mowry Br.	1990	1994	27	60	314.00	190.78	40.77
as CaCO3	mg/L	Central and Southern Delta	34	Clifton Court Intake	1986	1994	66	48	194.00	109.70	22.41
as CaCO3	mg/L	Central and Southern Delta	35	West Canal @ Clifton Court FB Intake	1990	1994	67	52	231.00	115.43	32.63
as CaCO3	mg/L	Central and Southern Delta	36	Old R. 6/10 mile below DMC intake	1988	1994	55	72	232.00	128.00	37.73
as CaCO3	mg/L	Central and Southern Delta	36	Old R. U/S from DMC Intake	1990	1994	59	72	262.00	136.78	46.53
as CaCO3	mg/L	Central and Southern Delta	37	Delta PP Headworks	1986	1996	150	39	161.00	104.50	19.74
as CaCO3	mg/L	Central and Southern Delta	38	DMC Intake @ Lindemann Rd	1986	1996	144	39	255.00	124.78	38.54
as CaCO3	mg/L	Central and Southern Delta	39	Grant Line/Fabian/Bell Canals nr Old R.	1990	1994	57	72	267.00	146.74	39.71
as CaCO3	mg/L	Central and Southern Delta	41	Grant Line Can @ Tracy Rd Br.	1989	1994	25	57	341.00	215.24	39.38
as CaCO3	mg/L	Central and Southern Delta	42	Old R. nr Tracy	1990	1994	29	57	350.00	238.79	37.57
as CaCO3	mg/L	Central and Southern Delta	43	San Joaquin R. @ Mossdale Br.	1989	1996	61	36	316.00	152.93	42.74
as CaCO3	mg/L	Central and Southern Delta	44	San Joaquin R. nr Vernalis - DWR	1986	1996	157	45	347.00	188.22	41.77
as CaCO3	mg/L	North Bay	8	Barker Sl. @ North Bay PP	1990	1996	97	32	166.00	99.71	24.30
	mg/L	Northern Delta	6	Sacramento R. @ Freeport Marina - CMP	1992	1996	37	30	82	54.95	
Total as CaCO3	mg/L	Northern Delta	6	Sacramento R. @ Freeport Marina - USGS	1973	1995	165	27	86.00	56.47	10.98
	mg/L	Northern Delta	7	Sacramento R. Mile 44	1992	1996	42	31	86.00	57.50	
as CaCO3	mg/L	Northern Delta	9	Delta Cross Channel nr Walnut Grove	1990	1994	22	36	81.00	57.09	10.16
as CaCO3	mg/L	Northern Delta	10	Georgiana Sl. @ Walnut Grove Bridge	1990	1994	23	36	81.00	57.17	9.02
as CaCO3	mg/L	Northern Delta	11	Sacramento R. @ Rio Vista Bridge	1988	1994	129	39	247.00	70.00	15.35
as CaCO3	mg/L	Northern Delta	12	Mokelumne R. below Georgiana Sl.	1990	1994	24	39	81.00	56.50	10.95
	uM	Northern Delta	18	Sacramento R. @ Collinsville	1994	1996	6	56	420.00	146.00	142.14
as CaCO3	mg/L	Northern Delta	45	Sacramento R. @ Greenes Landing	1986	1996	171	28	84.00	57.42	9.30
	uM	Western Delta	14	Pacheco Creek (outside area map)	1994	1996	3	48	990.00	370.00	537.07
	uM	Western Delta	15	Grizzly Bay (outside map area)	1994	1996	4	60	1100.00	552.50	570.46
	uM	Western Delta	16	Honker Bay	1994	1996	5	60	470.00	212.80	169.61
as CaCO3	mg/L	Western Delta	17	Sacramento R. @ Mallard Is.	1986	1996	178	36	2520.00	831.72	426.02

H1

SODIUM

Form	Unit	Area	Station Number	Station Name	Record Period Start	Record Period End	Count	Min	Max	Mean	Standard Deviation
Dissolved	mg/L	Central and Southern Delta	13	Little Potato Sl. @ Terminous	1988	1994	50	7	18.00	11.70	2.55
Dissolved	mg/L	Central and Southern Delta	20	San Joaquin R. @ Jersey Point	1990	1994	78	12	420.00	173.49	73.27
Dissolved	mg/L	Central and Southern Delta	21	Little Connection Sl. @ Empire Tr.	1985	1994	86	7	38.00	15.02	3.94
Dissolved	mg/L	Central and Southern Delta	22	Middle R. nr L@ham Sl.	1989	1992	12	25	56.00	39.17	12.33
Dissolved	mg/L	Central and Southern Delta	23	Connection Sl. @ Mandeville Is. Bridge	1989	1992	12	26	88.00	48.17	15.61
Dissolved	mg/L	Central and Southern Delta	24	Contra Costa PP #01	1990	1996	87	11	141.00	59.26	24.37
Dissolved	mg/L	Central and Southern Delta	25	Old R. N/O Rock Sl. (St 4b)	1988	1994	67	10	151.00	79.33	28.98
Dissolved	mg/L	Central and Southern Delta	26	Rock Sl. @ Old R.	1983	1994	168	10	172.00	67.52	30.09
Dissolved	mg/L	Central and Southern Delta	27	Middle R. @ Bacon Is. Br.	1989	1994	100	11	80.00	43.49	12.99
Dissolved	mg/L	Central and Southern Delta	28	Santa Fe-Bacon Is. Cut nr Old R.	1989	1994	62	22	129.00	66.31	23.63
Dissolved	mg/L	Central and Southern Delta	29	Woodward/N. Victoria Canal nr Old R.	1989	1994	62	23	125.00	60.24	23.17
Dissolved	mg/L	Central and Southern Delta	30	Middle R. @ Borden Hwy	1985	1996	179	11	86.00	39.94	12.40
Dissolved	mg/L	Central and Southern Delta	31	Old R. nr Byron (St 9)	1989	1996	107	12	128	57.72	19.68
Dissolved	mg/L	Central and Southern Delta	32	North Canal nr Old R.	1989	1994	64	24	95	50.63	15.22
Dissolved	mg/L	Central and Southern Delta	33	Middle R. @ Mowry Br.	1989	1994	28	24	144.00	90.46	18.17
Dissolved	mg/L	Central and Southern Delta	34	Clifton Court Intake	1983	1994	140	12	113.00	52.55	19.27
Dissolved	mg/L	Central and Southern Delta	35	West Canal @ Clifton Court FB Intake	1989	1994	69	15	105.00	63.84	19.54
Dissolved	mg/L	Central and Southern Delta	36	Old R. 6/10 mile below DMC intake	1990	1994	56	27	120.00	69.68	21.59
Dissolved	mg/L	Central and Southern Delta	37	Delta PP Headworks	1983	1996	277	10	116.00	55.99	17.31
Dissolved	mg/L	Central and Southern Delta	38	DMC Intake @ Lindemann Rd	1983	1996	275	14	229.00	60.81	21.49
Dissolved	mg/L	Central and Southern Delta	39	Grant Line/Fabian/Bell Canals nr Old R.	1989	1994	58	28	148.00	77.53	23.58
Dissolved	mg/L	Central and Southern Delta	40	Old R. U/S from DMC Intake	1989	1994	62	28	133.00	74.44	20.98
Dissolved	mg/L	Central and Southern Delta	41	Grant Line Can @ Tracy Rd Br.	1989	1994	26	23	178.00	105.46	26.31
Dissolved	mg/L	Central and Southern Delta	42	Old R. nr Tracy	1989	1994	30	24	179.00	119.20	25.00
Dissolved	mg/L	Central and Southern Delta	43	San Joaquin R. @ Mossdale Br.	1989	1996	64	12	167.00	76.72	25.92
Dissolved	mg/L	Central and Southern Delta	44	San Joaquin R. nr Vernalis - DWR	1983	1996	209	11	200.00	91.56	23.51
Dissolved	mg/L	North Bay	8	Barker Sl. @ North Bay PP	1988	1996	116	11	62.00	29.12	8.62
Dissolved	mg/L	Northern Delta	6	Sacramento R. @ Freeport Marina - USGS	1973	1995	166	2.9	18	9.54	2.99
Dissolved	mg/L	Northern Delta	9	Delta Cross Channel nr Walnut Grove	1989	1994	23	5	15.00	10.26	2.34
Dissolved	mg/L	Northern Delta	10	Georgiana Sl. @ Walnut Grove Bridge	1989	1994	24	5	15.00	10.25	1.83
Dissolved	mg/L	Northern Delta	11	Sacramento R. @ Rio Vista Bridge	1988	1994	131	6	142.00	21.18	11.08
Dissolved	mg/L	Northern Delta	12	Mokelumne R. below Georgiana Sl.	1990	1994	24	6	15.00	10.25	2.17
Dissolved	mg/L	Northern Delta	45	Sacramento R. @ Greenes Landing	1983	1996	209	3	19.00	10.26	2.39
Dissolved	mg/L	Western Delta	17	Sacramento R. @ Mallard Is.	1985	1996	187	8	3430.00	1275.20	703.72

C-031459

CONDUCTIVITY

Form	Unit	Area	Station Number	Station Name	Record Period Start	Record Period End	Count	Min	Max	Mean	Standard Deviation
	mho	Central and Southern Delta	13	Little Potato Sl. @ Terminous	1989	1992	9	180	492.00	346.22	73.69
	mho	Central and Southern Delta	19	San Joaquin River @ Antioch	1994	1996	7	131	3610.00	830.86	1259.89
	mho	Central and Southern Delta	20	San Joaquin R. @ Jersey Point	1990	1995	71	188	2790.00	1221.32	439.18
	mho	Central and Southern Delta	21	Little Connection Sl. @ Empire Tract	1990	1996	1244	56	605.00	154.95	27.67
	mho	Central and Southern Delta	22	Middle R. nr Latham Sl.	1985	1996	817	5	730.00	378.28	94.78
	mho	Central and Southern Delta	23	Connection Sl. @ Mandeville Is. Bridge	1983	1994	137	137	887.00	468.81	134.11
	mho	Central and Southern Delta	24	Contra Costa PP no 1	1990	1996	90	138	994.00	501.16	166.53
	mho	Central and Southern Delta	25	Old R. N/O Rock Sl. (St 4b)	1989	1994	56	220	793	461.6964	118.11
	mho	Central and Southern Delta	26	Rock Sl. @ Old R.	1989	1994	29	254	1435	987.5517	250.95
	mho	Central and Southern Delta	27	Middle R. @ Bacon Is. Br.	1985	1994	85	120	386.00	207.69	34.17
	mho	Central and Southern Delta	28	Santa Re-Bacon Is. Cut nr Old R.	1989	1996	104	160	912.00	484.22	151.08
	mho	Central and Southern Delta	29	Woodward/N. Victoria Canal nr Old R.	1989	1994	61	178	931.00	550.77	142.96
	mho	Central and Southern Delta	30	Middle R. @ Borden Hwy	1988	1994	49	120	249.00	176.49	31.21
	mho	Central and Southern Delta	31	Old R. nr Byron (St 9)	1989	1994	55	200	935.00	511.36	144.46
	mho	Central and Southern Delta	32	North Canal nr Old R.	1990	1994	23	108	230.00	163.13	30.27
	mho	Central and Southern Delta	33	Middle R. @ Mowry Br.	1985	1996	180	117	17800.00	6810.86	3785.39
	mho	Central and Southern Delta	34	Clifton Court Intake	1988	1996	208	109	609.00	323.23	81.50
	mho	Central and Southern Delta	35	West Canal @ Clifton Court FB Intake	1989	1996	211	117	1460.00	770.33	175.14
	mho	Central and Southern Delta	36	Old R. 6/10 mile below DMC intake	1989	1994	94	144	692.00	404.17	108.82
	mho	Central and Southern Delta	37	Delta PP Headworks	1989	1994	21	104	227.00	154.10	26.15
	mho	Central and Southern Delta	38	DMC Intake @ Lindemann Rd	1990	1996	272	126	1200.00	534.69	160.02
	mho	Central and Southern Delta	39	Grant Line/Fabian/Bell Canals nr Old R.	1989	1994	51	253	1150.00	658.59	183.69
	mho	Central and Southern Delta	40	Old R. U/S from DMC Intake	1989	1994	55	344	975.00	635.33	152.75
	mho	Central and Southern Delta	41	Grant Line Can @ Tracy Rd. Br.	1989	1994	25	248	1430.00	895.92	221.79
	mho	Central and Southern Delta	42	Old R. nr Tracy	1990	1994	49	340	988.00	607.00	156.35
	mho	Central and Southern Delta	43	San Joaquin R. @ Mossdale Br.	1989	1996	63	134	1470.00	638.16	223.43
	mho	Central and Southern Delta	44	San Joaquin R. nr Vernalis	1989	1994	60	149	1060.00	624.95	170.97
	mho	North Bay	8	Barker Sl. @ North Bay PP	1983	1996	506	135	877.00	377.13	116.41
	umho/cm	Northern Delta	6	Sacramento River @ Freeport Marina - CMP	1992	1995	49	54	254	134.9	
	umho/cm	Northern Delta	7	Sacramento River Mile 44	1992	1995	58	45	234.00	116.40	
	mho	Northern Delta	9	Delta Cross Channel nr Walnut Grove	1989	1992	10	200	700.00	408.40	111.07
	mho	Northern Delta	10	Georgiana Sl. @ Walnut Grove Bridge	1989	1994	23	101	228.00	157.87	28.70
	mho	Northern Delta	11	Sacramento R. @ Rio Vista Br.	1989	1994	55	200	938.00	547.20	136.67
	mho	Northern Delta	12	Mokelumne R. below Georgiana Sl.	1989	1994	27	274	1180.00	773.67	172.67
	mho	Northern Delta	18	Sacramento River @ Collinsville	1994	1996	6	118	4900.00	1114.50	1891.85
	mho	Northern Delta	18	Sacramento R. @ Mallard Is.	1989	1994	117	118	730.00	232.75	65.76
	mho	Northern Delta	45	Sacramento R. @ Greenes Landing	1983	1994	161	149	1250.00	539.22	187.45
	mho	Western Delta	14	Pacheco Creek (outside area map)	1994	1996	7	121	17900.00	10096.86	7599.62
	mho	Western Delta	15	Grizzly Bay (outside map area)	1994	1996	7	125	16000.00	7167.57	5541.19
	mho	Western Delta	16	Honker Bay	1994	1996	6	130	11000.00	3552.50	4046.63

C-031460

SPECIFIC CONDUCTANCE

Form	Unit	Area	Station Number	Station Name	Record Period Start	Record Period End	Count	Min	Max	Mean	Standard Deviation
	umhos/cm	Central and Southern Delta	13	Little Potato Sl. @ Terminous	1988	1994	50	120	249.00	177.42	32.94
	umhos/cm	Central and Southern Delta	20	San Joaquin R. @ Jersey Point	1990	1994	78	185	2790.00	1216.92	460.19
	umhos/cm	Central and Southern Delta	21	Little Connection Sl. @ Empire Tr.	1985	1994	86	120	386.00	208.59	35.25
	umhos/cm	Central and Southern Delta	22	Middle R. nr Latham Sl.	1989	1992	12	180	506.00	364.33	103.57
	umhos/cm	Central and Southern Delta	23	Connection Sl. @ Mandeville Is. Bridge	1989	1992	12	200	700.00	417.17	119.69
	umhos/cm	Central and Southern Delta	24	Contra Costa PP #01	1990	1996	87	146	988.00	516.47	170.65
	umhos/cm	Central and Southern Delta	25	Old R. N/O Rock Sl. (St 4b)	1988	1994	67	148	1090.00	629.78	186.34
	umhos/cm	Central and Southern Delta	26	Rock Sl. @ Old R.	1983	1994	170	156	1250.00	551.61	190.81
	umhos/cm	Central and Southern Delta	27	Middle R. @ Bacon Is. Br.	1989	1994	100	147	686.00	415.35	100.88
	umhos/cm	Central and Southern Delta	28	Santa Fe-Bacon Is. Cut nr Old R.	1989	1994	62	200	979.00	553.18	152.60
	umhos/cm	Central and Southern Delta	29	Woodward/N. Victoria Canal nr Old R.	1989	1994	62	200	958.00	519.02	152.25
	umhos/cm	Central and Southern Delta	30	Middle R. @ Borden Hwy	1985	1996	179	153	726	388.80	95.22
	umhos/cm	Central and Southern Delta	31	Old R. nr Byron (St 9)	1989	1996	106	165	947	495.25	127.37
	umhos/cm	Central and Southern Delta	32	North Canal nr Old R.	1989	1994	64	220	770.00	461.28	114.63
	umhos/cm	Central and Southern Delta	33	Middle R. @ Mowry Br.	1989	1994	28	261	1200.00	798.18	150.62
	umhos/cm	Central and Southern Delta	34	Clifton Court Intake	1983	1994	141	137	875.00	475.65	136.47
	umhos/cm	Central and Southern Delta	35	West Canal @ Clifton Court FB Intake	1989	1994	69	179	915.00	554.70	148.74
	umhos/cm	Central and Southern Delta	36	Old R. 6/10 mile below DMC intake	1990	1994	56	321	1000.00	610.20	168.56
	umhos/cm	Central and Southern Delta	37	Delta PP Headworks	1983	1996	271	163	877.00	500.20	123.69
	umhos/cm	Central and Southern Delta	38	DMC Intake @ Lindemann Rd	1983	1996	269	169	1200.00	548.28	167.80
	umhos/cm	Central and Southern Delta	39	Grant Line/Fabian/Bell Canals nr Old R.	1989	1994	58	318	1210.00	677.26	177.29
	umhos/cm	Central and Southern Delta	40	Old R. U/S from DMC Intake	1989	1994	62	329	1140.00	643.42	164.71
	umhos/cm	Central and Southern Delta	41	Grant Line Can @ Tracy Rd Br.	1989	1994	26	244	1430.00	913.96	215.01
	umhos/cm	Central and Southern Delta	42	Old R. nr Tracy	1989	1994	30	249	1520.00	1023.23	202.40
	umhos/cm	Central and Southern Delta	43	San Joaquin R. @ Mossdale Br.	1989	1996	65	143	1370.00	671.86	199.35
	umhos/cm	Central and Southern Delta	44	San Joaquin R. nr Vernalis - DWR	1983	1996	213	117	1550.00	784.93	178.90
	umhos/cm	North Bay	8	Barker Sl. @ North Bay PP	1988	1996	116	122	609.00	332.91	79.06
Field	us/cm	Northern Delta	6	Sacramento R. @ Freeport Marina - USGS	1973	1995	345	43	270	146.32	34.63
Lab	us/cm	Northern Delta	6	Sacramento R. @ Freeport Marina - USGS	1973	1995	108	79	253.00	161.45	34.60
	umhos/cm	Northern Delta	9	Delta Cross Channel nr Walnut Grove	1989	1994	23	105	225.00	160.43	29.58
	umhos/cm	Northern Delta	10	Georgiana Sl. @ Walnut Grove Bridge	1989	1994	24	101	227.00	162.25	25.07
	umhos/cm	Northern Delta	11	Sacramento R. @ Rio Vista Bridge	1988	1994	132	120	1170.00	245.01	79.58
	umhos/cm	Northern Delta	12	Mokelumne R. below Georgiana Sl.	1990	1994	24	109	226.00	163.46	30.61
	umhos/cm	Northern Delta	45	Sacramento R. @ Greenes Landing	1983	1996	209	70	253.00	162.61	25.72
	umhos/cm	Western Delta	17	Sacramento R. @ Mallard Is.	1985	1996	187	120	18500.00	7385.23	3872.72

C-031461

C-031462

TDS

Form	Unit	Area	Station Number	Station Name	Record Period Start	End	Count	Min	Max	Mean	Standard Deviation
	mg/L	Central and Southern Delta	13	Little Potato Sl. @ Terminous	1988	1994	46	75	151.00	108.91	20.02
	mg/L	Central and Southern Delta	20	San Joaquin R. @ Jersey Point	1990	1994	26	114	1310.00	627.58	265.28
	mg/L	Central and Southern Delta	21	Little Connection Sl. @ Empire Tr.	1989	1994	26	49	207.00	122.00	21.89
	mg/L	Central and Southern Delta	22	Middle R. nr L@ham Sl.	1989	1992	12	120	282.00	203.83	56.91
	mg/L	Central and Southern Delta	23	Connection Sl. @ Mandeville Is. Bridge	1989	1992	12	130	372.00	229.25	64.22
	mg/L	Central and Southern Delta	24	Contra Costa PP #01	1991	1996	85	86	529.00	283.35	107.23
	mg/L	Central and Southern Delta	25	Old R. N/O Rock Sl. (St 4b)	1988	1994	24	84	495.00	305.58	97.38
	mg/L	Central and Southern Delta	26	Rock Sl. @ Old R.	1986	1994	42	86	544.00	302.26	85.13
	mg/L	Central and Southern Delta	27	Middle R. @ Bacon Is. Br.	1989	1994	61	88	378.00	226.84	57.88
	mg/L	Central and Southern Delta	28	Santa Fe-Bacon Is. Cut nr Old R.	1989	1994	20	130	418.00	272.10	70.38
	mg/L	Central and Southern Delta	29	Woodward/N. Victoria Canal nr Old R.	1989	1994	20	130	404.00	263.75	67.98
	mg/L	Central and Southern Delta	30	Middle R. @ Borden Hwy	1986	1996	114	92	399.00	219.78	52.52
	mg/L	Central and Southern Delta	31	Old R. nr Byron (St 9)	1989	1996	58	92	425.00	225.57	63.07
	mg/L	Central and Southern Delta	32	North Canal nr Old R.	1989	1994	19	140	358	240.42	54.48
	mg/L	Central and Southern Delta	33	Middle R. @ Mowry Br.	1989	1994	28	152	712	461.54	88.92
	mg/L	Central and Southern Delta	34	Clifton Court Intake	1986	1994	67	91	496.00	286.42	67.26
	mg/L	Central and Southern Delta	35	West Canal @ Clifton Court FB Intake	1989	1994	23	104	492.00	288.87	68.23
	mg/L	Central and Southern Delta	36	Old R. 6/10 mile below DMC intake	1990	1994	16	194	528.00	331.44	79.86
	mg/L	Central and Southern Delta	37	Delta PP Headworks	1986	1996	106	101	475.00	266.02	71.82
	mg/L	Central and Southern Delta	38	DMC Intake @ Lindemann Rd	1986	1996	105	98	613.00	297.02	89.38
	mg/L	Central and Southern Delta	39	Grant Line/Fabian/Bell Canals nr Old R.	1989	1994	19	180	663.00	380.11	98.85
	mg/L	Central and Southern Delta	40	Old R. U/S from DMC Intake	1989	1994	21	188	505.00	335.81	83.39
	mg/L	Central and Southern Delta	41	Grant Line Can @ Tracy Rd Br.	1989	1994	26	142	886.00	538.12	131.77
	mg/L	Central and Southern Delta	42	Old R. nr Tracy	1989	1994	30	142	907.00	605.90	125.79
	mg/L	Central and Southern Delta	43	San Joaquin R. @ Mossdale Br.	1989	1996	64	90	852.00	401.56	123.40
	mg/L	Central and Southern Delta	44	San Joaquin R. nr Vernalis - DWR	1986	1996	153	114	897.00	483.44	113.16
	mg/L	North Bay	8	Barker Sl. @ North Bay PP	1990	1996	97	84	297	192.41	47.46
	mg/L	Northern Delta	9	Delta Cross Channel nr Walnut Grove	1989	1994	23	68	139.00	98.48	19.17
	mg/L	Northern Delta	10	Georgiana Sl. @ Walnut Grove Bridge	1989	1994	24	64	134.00	98.92	14.53
	mg/L	Northern Delta	11	Sacramento R. @ Rio Vista Bridge	1988	1994	83	55	427.00	137.82	37.86
	mg/L	Northern Delta	12	Mokelumne R. below Georgiana Sl.	1990	1994	24	72	138.00	101.25	18.88
	mg/L	Northern Delta	45	Sacramento R. @ Greenes Landing	1986	1996	154	49	151.00	101.14	16.48
	mg/L	Western Delta	17	Sacramento R. @ Mallard Is.	1986	1996	136	80	11000.00	4044.47	2391.85

C—031462

SALINITY

Form	Unit	Area	Station Number	Station Name	Record Period Start	Record Period End	Count	Min	Max	Mean	Standard Deviation
	o/oo	Central and Southern Delta	19	San Joaquin River @ Antioch	1994	1996	8	BDL	3.00	0.97	1.50
	o/oo	Northern Delta	18	Sacramento River @ Collinsville	1994	1996	8	BDL	3.40	1.10	1.70
	o/oo	Western Delta	14	Pacheco Creek (outside area map)	1994	1996	8	BDL	12.6	6.33	4.78
	o/oo	Western Delta	15	Grizzly Bay (outside map area)	1994	1996	8	BDL	8.00	4.42	2.70
	o/oo	Western Delta	16	Honker Bay	1994	1996	6	BDL	4.00	2.90	1.22

C-031464

CADMIUM

Form	Unit	Area	Station Number	Station Name	Record Period Start	Record Period End	Count	Min	Max	Mean	Standard Deviation
Total	ug/L	Central and Southern Delta	19	San Joaquin River @ Antioch	1994	1996	8	0.017	0.07	0.03	0.02
Total	ug/L	Northern Delta	6	Sacramento River @ Freeport Marina - CMP	1992	1996	51	<0.03	2.5		
Total	ug/L	Northern Delta	6	Sacramento River @ Freeport Marina - USG.	1973	1995	97	3	160.00	16.82	24.71
Total	ug/L	Northern Delta	7	Sacramento River Mile 44	1992	1996	57	<0.03	0.78		
Total	ug/L	Northern Delta	18	Sacramento River @ Collinsville	1994	1996	8	0.02	0.04	0.03	0.01
Total	ug/L	Western Delta	14	Pacheco Creek (outside area map)	1994	1996	8	0.024	0.40	0.09	0.13
Total	ug/L	Western Delta	15	Grizzly Bay (outside map area)	1994	1996	8	0.021	0.10	0.05	0.03
Total	ug/L	Western Delta	16	Honker Bay	1994	1996	6	0.023	0.40	0.10	0.15

C-031464

COPPER

Form	Unit	Area	Station Number	Station Name	Record Period Start	Record Period End	Count	Min	Max	Mean	Standard Deviation
Total	ug/L	Central and Southern Delta	19	San Joaquin R. @ Antioch	1994	1996	8	2.77	5.31	3.70	0.83
Dissolved	mg/L	Central and Southern Delta	24	Contra Costa PP #01	1993	1996	56	0	0.01	0.00	0.00
Dissolved	mg/L	Central and Southern Delta	37	Delta PP Headworks	1987	1996	53	0	0.01	0.00	0.00
Dissolved	mg/L	Central and Southern Delta	38	DMC Intake @ Lindemann Rd	1993	1996	28	0	0.01	0.00	0.00
Dissolved	mg/L	Central and Southern Delta	44	San Joaquin R. nr Vernalis - DWR	1986	1996	74	0	0.01	0.00	0.00
Dissolved	mg/L	North Bay	8	Barker Sl. @ North Bay PP	1993	1996	53	0	0.01	0.00	0.00
Total	ug/L	Northern Delta	6	Sacramento R. @ Freeport Marina - CMP	1992	1996	53	1.6	14.5		
Total	ug/L	Northern Delta	6	Sacramento R. @ Freeport Marina - USGS	1973	1995	60	0	20.00	6.98	8.64
Total	ug/L	Northern Delta	7	Sacramento R. Mile 44	1992	1996	59	1.2	16.00		
Total	ug/L	Northern Delta	18	Sacramento R. @ Collinsville	1994	1996	7	2.62	5.82	4.26	1.09
Dissolved	mg/L	Northern Delta	45	Sacramento R. @ Greenes Landing	1993	1996	52	0	0.01	0.00	0.00
Total	ug/L	Western Delta	14	Pacheco Creek (outside area map)	1994	1996	8	2.49	7.86	5.01	1.76
Total	ug/L	Western Delta	15	Grizzly Bay (outside map area)	1994	1996	8	3.28	11.54	7.31	3.27
Total	ug/L	Western Delta	16	Honker Bay	1994	1996	6	3.05	7.87	5.10	1.57

C-031465

MERCURY

Form	Unit	Area	Station Number	Station Name	Record Period Start	Record Period End	Count	Min	Max	Mean	Standard Deviation
Total	ug/L	Central and Southern Delta	19	San Joaquin River @ Antioch	1994	1996	8	0.0044	0.01	0.01	0.00
Total	ug/L	Central and Southern Delta	37	Delta PP Headworks	1992	1996	8	0	0.00	0.00	0.00
Total	ug/L	Central and Southern Delta	38	DMC Intake @ Lindemann Rd	1992	1996	9	0	0.00	0.00	0.00
Total	ng/L	Northern Delta	6	Sacramento River @ Freeport Marina - CMP	1992	1996	31	1.47	36.19		
Total	ug/L	Northern Delta	6	Sacramento River @ Freeport Marina - USG.	1973	1995	92	0	15.00	0.45	1.75
Total	ng/L	Northern Delta	7	Sacramento River Mile 44	1992	1996	34	3.66	73.41		
Total	ug/L	Northern Delta	18	Sacramento River @ Collinsville	1994	1996	8	0.0045	0.01	0.01	0.00
Total	ug/L	Western Delta	14	Pacheco Creek (outside area map)	1994	1996	8	0.006	0.03	0.01	0.01
Total	ug/L	Western Delta	15	Grizzly Bay (outside map area)	1994	1996	8	0.0093	0.04	0.02	0.01
Total	ug/L	Western Delta	16	Honker Bay	1994	1996	6	0.0062	0.03	0.01	0.01

C—031466

C-031467

SELENIUM

Form	Unit	Area	Station Number	Station Name	Record Period Start	Record Period End	Count	Min	Max	Mean	Standard Deviation
Total	ug/L	Central and Southern Delta	19	San Joaquin R. @ Antioch	1994	1996	8	0.06	0.33	0.18	0.10
Dissolved	mg/L	Central and Southern Delta	21	Little Connection Sl. @ Empire Tr.	1985	1990	3	0.00	0.00	0.00	0.00
Dissolved	mg/L	Central and Southern Delta	24	Contra Costa PP #01	1993	1996	55	0.00	0.00	0.00	0.00
Dissolved	mg/L	Central and Southern Delta	26	Rock Sl. @ Old R.	1989	1996	18	0.00	0.00	0.00	0.00
Dissolved	mg/L	Central and Southern Delta	30	Middle R. @ Borden Hwy	1985	1990	12	0.00	0.00	0.00	0.00
Dissolved	mg/L	Central and Southern Delta	31	Old R. nr Byron (St 9)	1989	1996	6	0.00	0.00	0.00	0.00
Dissolved	mg/L	Central and Southern Delta	34	Clifton Court Intake	1984	1992	33	0.00	0.00	0.00	0.00
Dissolved	mg/L	Central and Southern Delta	37	Delta PP Headworks	1984	1996	221	0	0.003	0.00	0.00
Dissolved	mg/L	Central and Southern Delta	38	DMC Intake @ Lindemann Rd	1984	1996	223	0	0.005	0.00	0.00
Dissolved	mg/L	Central and Southern Delta	42	Old R. nr Tracy	1989	1991	5	0.00	0.01	0.00	0.00
Dissolved	mg/L	Central and Southern Delta	43	San Joaquin R. @ Mossdale Br.	1989	1996	35	0.00	0.01	0.00	0.00
Dissolved	mg/L	Central and Southern Delta	44	San Joaquin R. nr Vernalis - DWR	1984	1996	166	0.00	0.01	0.00	0.00
Dissolved	mg/L	North Bay	8	Barker Sl. @ North Bay PP	1993	1996	54	0.00	0.00	0.00	0.00
Total	ug/L	Northern Delta	6	Sacramento R. @ Freeport Marina - CMP	1992	1996	26	<0.87	<1		
Total	ug/L	Northern Delta	6	Sacramento R. @ Freeport Marina - USGS	1973	1995	95	0.00	290.00	28.07	35.99
Total	ug/L	Northern Delta	7	Sacramento R. Mile 44	1992	1996	29	<1	<1		
Total	ug/L	Northern Delta	18	Sacramento R. @ Collinsville	1994	1996	7	0.11	0.30	0.20	0.07
Dissolved	mg/L	Northern Delta	45	Sacramento R. @ Greenes Landing	1984	1996	73	0.00	0.00	0.00	0.00
Total	ug/L	Western Delta	14	Pacheco Creek (outside area map)	1994	1996	8	0.09	0.32	0.20	0.08
Total	ug/L	Western Delta	15	Grizzly Bay (outside map area)	1994	1996	8	0.07	13.00	1.80	4.53
Total	ug/L	Western Delta	16	Honker Bay	1994	1996	6	0.11	0.28	0.18	0.06
Dissolved	mg/L	Western Delta	17	Sacramento R. @ Mallard Is.	1985	1995	15	0.00	0.00	0.00	0.00

C—031467

ZINC

Form	Unit	Area	Station Number	Station Name	Record Period Start	Record Period End	Count	Min	Max	Mean	Standard Deviation
Dissolved	ug/L	Central and Southern Delta	19	San Joaquin River @ Antioch	1994	1996	8	2.4	9.39	4.87	2.38
Dissolved	mg/L	Central and Southern Delta	37	Delta PP Headworks	1987	1996	8	0	4.33	0.55	1.08
Dissolved	mg/L	Central and Southern Delta	44	San Joaquin R. nr Vernalis - DWR	1986	1989	41	0	0.12	0.01	0.02
Dissolved	ug/L	Northern Delta	6	Sacramento River @ Freeport Marina - CMP	1992	1996	52	<1.5	27		
Dissolved	ug/L	Northern Delta	6	Sacramento River @ Freeport Marina - USGS	1973	1995	111	0	92.00	10.41	12.29
Dissolved	ug/L	Northern Delta	7	Sacramento River Mile 44	1992	1996	59	<4	18.00		
Dissolved	ug/L	Northern Delta	18	Sacramento River @ Collinsville	1994	1996	8	2.75	11.49	6.41	3.05
Dissolved	ug/L	Western Delta	14	Pacheco Creek (outside area map)	1994	1996	8	3.45	16.89	7.89	4.27
Dissolved	ug/L	Western Delta	15	Grizzly Bay (outside map area)	1994	1996	8	5.15	23.00	12.34	6.46
Dissolved	ug/L	Western Delta	16	Honker Bay	1994	1996	6	4.15	16.09	8.13	4.16

C-031469

CHLORDANE

Form	Unit	Area	Station Number	Station Name	Record Period Start	Record Period End	Count	Min	Max	Mean	Standard Deviation
Total	pg/L	Central and Southern Delta	19	San Joaquin River @ Antioch	1994	1996	6	69	254.00	150.83	65.03
Total	pg/L	Northern Delta	18	Sacramento River @ Collinsville	1994	1996	7	83	214.00	124.86	42.98
Total	pg/L	Western Delta	15	Grizzly Bay (outside map area)	1994	1996	6	59	241	170.1667	60.31

C-031469

CHLORPYRIFOS

Form	Unit	Area	Station Number	Station Name	Record Period Start	Record Period End	Count	Min	Max	Mean	Standard Deviation
Total	pg/L	Central and Southern Delta	19	San Joaquin River @ Antioch	1994	1996	5	0	35259.00	9191.80	14862.38
Total	ug/L	Northern Delta	6	Sacramento River @ Freeport Marina - CMP	1992	1995	20	<0.5	<0.5	<0.5	
Total	ug/L	Northern Delta	7	Sacramento River Mile 44	1992	1995	20	<0.5	<0.5	<0.5	
Total	pg/L	Northern Delta	18	Sacramento River @ Collinsville	1994	1996	6	1400	46629.00	10621.50	17798.18
Total	pg/L	Western Delta	15	Grizzly Bay (outside map area)	1994	1996	5	29	390.80	170.96	140.03

C-031470

DIAZINON

Form	Unit	Area	Station Number	Station Name	Record Period Start	Record Period End	Count	Min	Max	Mean	Standard Deviation
Total	pg/L	Central and Southern Delta	19	San Joaquin River @ Antioch	1994	1996	5	20	640.00	239.40	238.50
	ug/L	Northern Delta	6	Sacramento River @ Freeport Marina - CMP	1992	1996	20	<0.5	0.6	<0.5	
	ug/L	Northern Delta	7	Sacramento River Mile 44	1992	1996	20	<0.5	0.70	<0.5	
Total	pg/L	Northern Delta	18	Sacramento River @ Collinsville	1994	1996	5	21	1416.00	404.20	592.79
Total	pg/L	Western Delta	15	Grizzly Bay (outside map area)	1994	1996	6	1700	14786.00	5714.33	4999.48

C-031471

DDT

Form	Unit	Area	Station Number	Station Name	Record Period Start	Record Period End	Count	Min	Max	Mean	Standard Deviation
Total	pg/L	Central and Southern Delta	19	San Joaquin River @ Antioch	1994	1996	6	72	430.40	306.97	137.91
Total	pg/L	Northern Delta	18	Sacramento River @ Collinsville	1994	1996	7	52	728.00	404.19	224.37
Total	pg/L	Western Delta	15	Grizzly Bay (outside map area)	1994	1996	7	148	1754	693.26	585.16

C-031472

PCB

Form	Unit	Area	Station Number	Station Name	Record Period Start	Record Period End	Count	Min	Max	Mean	Standard Deviation
Total	pg/L	Central and Southern Delta	19	San Joaquin River @ Antioch	1994	1996	7	0	762.00	281.57	237.67
Total	pg/L	Northern Delta	18	Sacramento River @ Collinsville	1994	1996	7	160	850.00	400.00	254.65
Total	pg/L	Western Delta	15	Grizzly Bay (outside map area)	1994	1996	7	168	2435	784.7143	785.4968

C-031473

BROMIDE

Form	Unit	Area	Station Number	Station Name	Record Period Start	Record Period End	Count	Min	Max	Mean	Standard Deviation
Dissolved	mg/L	Central and Southern Delta	13	Little Potato Sl. @ Terminous	1990	1994	25	0.02	0.07	0.03	0.01
Dissolved	mg/L	Central and Southern Delta	20	San Joaquin R. @ Jersey Point	1990	1994	81	0.03	2.60	1.07	0.46
Dissolved	mg/L	Central and Southern Delta	21	Little Connection Sl. @ Empire Tr.	1990	1994	23	0.02	0.13	0.06	0.02
Dissolved	mg/L	Central and Southern Delta	24	Contra Costa PP #01	1990	1996	87	0.03	0.77	0.28	0.14
Dissolved	mg/L	Central and Southern Delta	25	Old R. N/O Rock Sl. (St 4b)	1990	1994	66	0.03	0.91	0.46	0.19
Dissolved	mg/L	Central and Southern Delta	26	Rock Sl. @ Old R.	1990	1994	94	0.04	0.92	0.46	0.20
Dissolved	mg/L	Central and Southern Delta	27	Middle R. @ Bacon Is. Br.	1990	1994	100	0.03	0.42	0.21	0.07
Dissolved	mg/L	Central and Southern Delta	28	Santa Fe-Bacon Is. Cut nr Old R.	1990	1994	61	0.06	0.77	0.38	0.16
Dissolved	mg/L	Central and Southern Delta	29	Woodward/N. Victoria Canal nr Old R.	1990	1994	61	0.07	0.75	0.34	0.14
Dissolved	mg/L	Central and Southern Delta	30	Middle R. @ Borden Hwy	1990	1996	94	0.03	0.51	0.18	0.07
Dissolved	mg/L	Central and Southern Delta	31	Old R. nr Byron (St 9)	1990	1996	103	0.04	0.77	0.31	0.11
Dissolved	mg/L	Central and Southern Delta	32	North Canal nr Old R.	1990	1994	63	0.07	0.48	0.26	0.08
Dissolved	mg/L	Central and Southern Delta	33	Middle R. @ Mowry Br.	1990	1994	24	0.06	0.69	0.39	0.10
Dissolved	mg/L	Central and Southern Delta	34	Clifton Court Intake	1990	1994	61	0	0.63	0.27	0.13
Dissolved	mg/L	Central and Southern Delta	35	West Canal @ Clifton Court FB Intake	1990	1994	68	0.05	0.62	0.34	0.11
Dissolved	mg/L	Central and Southern Delta	36	Old R. 6/10 mile below DMC intake	1990	1994	58	0.08	0.60	0.37	0.11
Dissolved	mg/L	Central and Southern Delta	36	Old R. U/S from DMC Intake	1990	1994	59	0.08	0.60	0.38	0.11
Dissolved	mg/L	Central and Southern Delta	37	Delta PP Headworks	1990	1996	149	0.05	0.65	0.29	0.10
Dissolved	mg/L	Central and Southern Delta	38	DMC Intake @ Lindemann Rd	1990	1996	146	0.04	0.62	0.28	0.10
Dissolved	mg/L	Central and Southern Delta	39	Grant Line/Fabian/Bell Canals nr Old R.	1990	1994	57	0.08	0.60	0.38	0.10
Dissolved	mg/L	Central and Southern Delta	41	Grant Line Can @ Tracy Rd Br.	1990	1994	21	0.052	0.70	0.39	0.13
Dissolved	mg/L	Central and Southern Delta	42	Old R. nr Tracy	1990	1994	24	0.08	0.78	0.47	0.10
Dissolved	mg/L	Central and Southern Delta	43	San Joaquin R. @ Mossdale Br.	1990	1996	57	0.03	0.60	0.28	0.09
Dissolved	mg/L	Central and Southern Delta	44	San Joaquin R. nr Vernalis - DWR	1990	1996	82	0.04	0.65	0.36	0.10
Dissolved	mg/L	North Bay	8	Barker Sl. @ North Bay PP	1990	1996	108	0	0.23	0.05	0.02
Dissolved	mg/L	Northern Delta	9	Delta Cross Channel nr Walnut Grove	1990	1994	20	0	0.05	0.02	0.01
Dissolved	mg/L	Northern Delta	10	Georgiana Sl. @ Walnut Grove Bridge	1990	1994	21	0	0.05	0.02	0.01
Dissolved	mg/L	Northern Delta	11	Sacramento R. @ Rio Vista Bridge	1990	1994	114	0	1.02	0.09	0.08
Dissolved	mg/L	Northern Delta	12	Mokelumne R. below Georgiana Sl.	1990	1994	22	0	0.05	0.02	0.01
Dissolved	mg/L	Northern Delta	45	Sacramento R. @ Greenes Landing	1990	1996	123	0	0.52	0.02	0.02
Dissolved	mg/L	Western Delta	17	Sacramento R. @ Mallard Is.	1990	1996	136	0.02	22.60	8.18	4.44

C-031474

CHLORIDE

Form	Unit	Area	Station Number	Station Name	Record Period Start	Record Period End	Count	Min	Max	Mean	Standard Deviation
Dissolved	mg/L	Central and Southern Delta	13	Little Potato Sl. @ Terminous	1988	1994	50	4	17.00	10.32	2.99
Dissolved	mg/L	Central and Southern Delta	20	San Joaquin R. @ Jersey Point	1990	1994	78	13	746.00	300.59	134.94
Dissolved	mg/L	Central and Southern Delta	21	Little Connection Sl. @ Empire Tr.	1985	1994	86	4	60.00	16.59	6.72
Dissolved	mg/L	Central and Southern Delta	24	Contra Costa PP #01	1990	1996	87	11	233.00	90.95	42.36
Dissolved	mg/L	Central and Southern Delta	25	Old R. N/O Rock Sl. (St 4b)	1988	1994	67	10	257.00	130.60	53.74
Dissolved	mg/L	Central and Southern Delta	26	Rock Sl. @ Old R.	1983	1994	170	12	303.00	108.70	53.71
Dissolved	mg/L	Central and Southern Delta	27	Middle R. @ Bacon Is. Br.	1989	1994	100	11	133.00	62.54	20.78
Dissolved	mg/L	Central and Southern Delta	28	Santa Fe-Bacon Is. Cut nr Old R.	1989	1994	62	27	220.00	104.44	44.91
Dissolved	mg/L	Central and Southern Delta	29	Woodward/N. Victoria Canal nr Old R.	1989	1994	62	3	213.00	94.81	42.71
Dissolved	mg/L	Central and Southern Delta	30	Middle R. @ Borden Hwy	1985	1996	179	12	139.00	56.36	20.76
Dissolved	mg/L	Central and Southern Delta	31	Old R. nr Byron (St 9)	1989	1996	108	6	211.00	89.49	40.63
Dissolved	mg/L	Central and Southern Delta	32	North Canal nr Old R.	1989	1994	64	3	155.00	75.13	24.24
Dissolved	mg/L	Central and Southern Delta	33	Middle R. @ Mowry Br.	1989	1994	28	27	240	126.54	32.67
Dissolved	mg/L	Central and Southern Delta	34	Clifton Court Intake	1983	1994	140	13	190	76.79	32.72
Dissolved	mg/L	Central and Southern Delta	35	West Canal @ Clifton Court FB Intake	1989	1994	69	5	177.00	97.36	32.21
Dissolved	mg/L	Central and Southern Delta	36	Old R. 6/10 mile below DMC intake	1990	1994	56	37	181.00	105.93	31.75
Dissolved	mg/L	Central and Southern Delta	36	Old R. U/S from DMC Intake	1989	1994	62	38	177.00	108.68	27.07
Dissolved	mg/L	Central and Southern Delta	37	Delta PP Headworks	1983	1996	280	14	186.00	83.56	29.60
Dissolved	mg/L	Central and Southern Delta	38	DMC Intake @ Lindemann Rd	1983	1996	275	15	198.00	83.81	29.13
Dissolved	mg/L	Central and Southern Delta	39	Grant Line/Fabian/Bell Canals nr Old R.	1989	1994	58	36	180.00	110.67	30.78
Dissolved	mg/L	Central and Southern Delta	41	Grant Line Can @ Tracy Rd Br.	1989	1994	26	26	226.00	139.81	32.55
Dissolved	mg/L	Central and Southern Delta	42	Old R. nr Tracy	1989	1994	30	27	255.00	161.07	31.95
Dissolved	mg/L	Central and Southern Delta	43	San Joaquin R. @ Mossdale Br.	1989	1996	64	11	197.00	93.22	29.37
Dissolved	mg/L	Central and Southern Delta	44	San Joaquin R. nr Vernalis - DWR	1983	1996	213	10	221.00	107.53	26.75
Dissolved	mg/L	North Bay	8	Barker Sl. @ North Bay PP	1988	1996	116	5	74.00	25.78	9.05
Total	mg/L	Northern Delta	6	Sacramento R. @ Freeport Marina - USGS	1973	1995	166	1.8	15	6.40	2.39
Dissolved	mg/L	Northern Delta	9	Delta Cross Channel nr Walnut Grove	1989	1994	23	1	12.00	7.26	2.11
Dissolved	mg/L	Northern Delta	10	Georgiana Sl. @ Walnut Grove Bridge	1989	1994	24	2	11.00	7.13	1.86
Dissolved	mg/L	Northern Delta	11	Sacramento R. @ Rio Vista Bridge	1988	1994	132	3	277.00	23.70	18.35
Dissolved	mg/L	Northern Delta	12	Mokelumne R. below Georgiana Sl.	1990	1994	24	4	14.00	7.75	2.16
Dissolved	mg/L	Northern Delta	45	Sacramento R. @ Greenes Landing	1983	1996	209	1	19.00	7.13	1.87
Dissolved	mg/L	Western Delta	17	Sacramento R. @ Mallard Is.	1985	1996	187	7	6060.00	2311.30	1286.70

TOTAL ORGANIC CARBON

Form	Unit	Area	Station Number	Station Name	Record Period Start	Record Period End	Count	Min	Max	Mean	Standard Deviation
	mg/L	Northern Delta	6	Sacramento River @ Freeport Marina - CMP	1992	1996	41	<1	6.8		
	mg/L	Northern Delta	6	Sacramento River @ Freeport Marina - USGS	1973	1995	91	1.2	7.90	2.77	1.18
	mg/L	Northern Delta	7	Sacramento River Mile 44	1992	1996	47	<3	6.10		

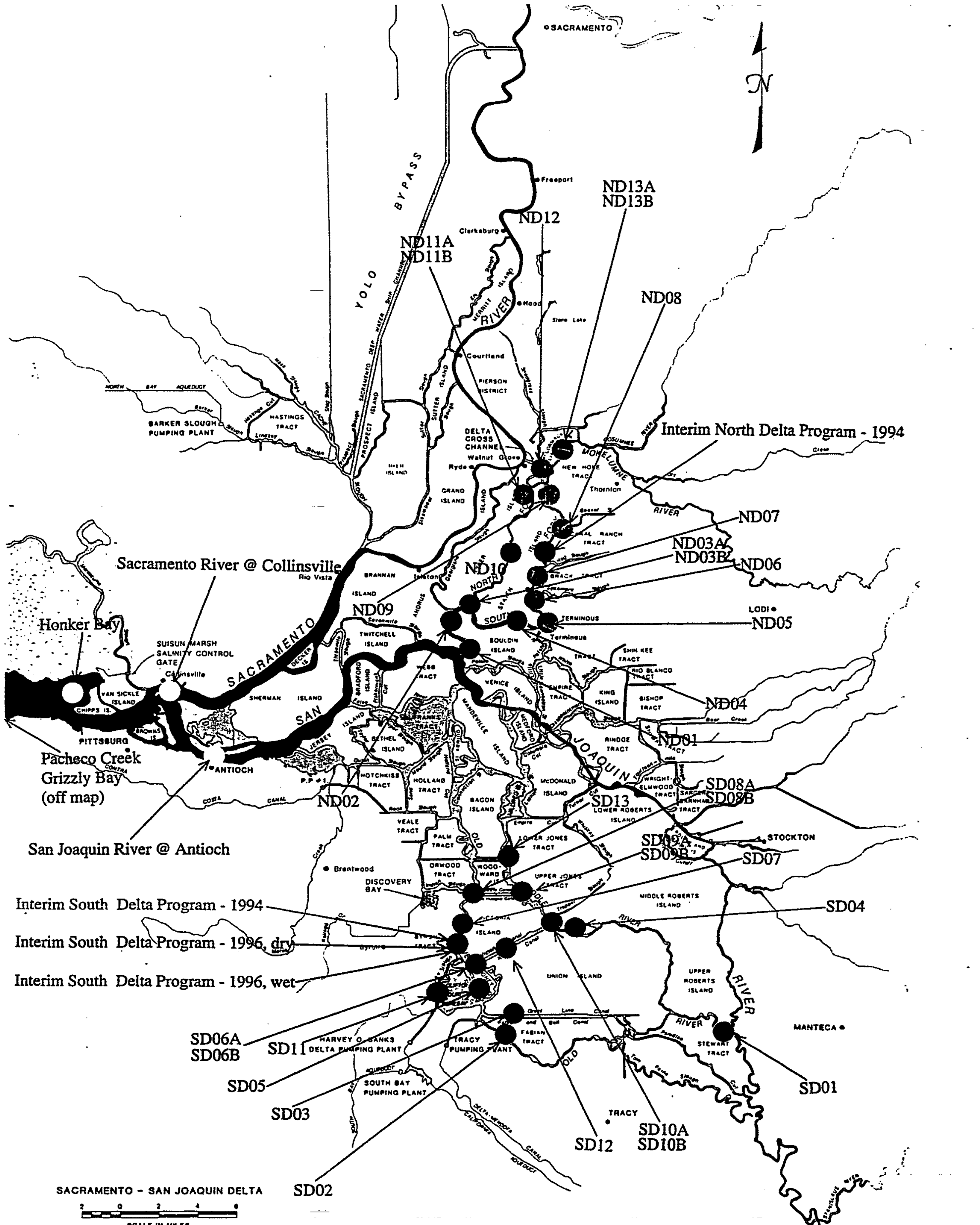
C-031476

BIOLOGICAL INDICATORS

Form	Unit	Area	Station Number	Station Name	Record Period Start	Record Period End	Count	Min	Max	Mean	Standard Deviation
Fecal Coliform, membrance filter m-fc media-fc media		Northern Delta	6	Sacramento River @ Freeport Marina - USG	1973	1995	41	3	1200	117.66	205.53
Fecal Streptococci - kf agar	colonies/100mL	Northern Delta	6	Sacramento River @ Freeport Marina - USG	1973	1995	102	2	2000.00	165.54	329.21

C-031477

SEDIMENT MONITORING LOCATIONS



Program Name and year(s) of study	Cadmium	Cadmium	Cadnium (STLC)	Cadmium (DIWET)	Cadmium (WET)
	mg/kg - wet	mg/kg - dry	mg/kg	mg/L	mg/L
Interim North Delta Program - 1992					
ND01	ND				
ND02	ND				
ND03A	ND				
ND03B	ND				
ND04	ND				
ND05	ND				
ND06	ND				
ND07	ND				
ND08	ND				
ND09A	ND				
ND10	ND				
ND11A	ND				
ND11B	ND				
ND12	ND				
ND13A	ND				
ND13B	ND				
Interim North Delta Program - 1994					
Count	19	29		29	29
Min	ND	ND		ND	ND
Max	0.70	1.11		ND	0.02
Average	0.44	0.61		n/a	0.01
Standard Deviation	0.21	0.36		n/a	0.01
Interim South Delta Program - 1992					
SD01	ND				
SD02	ND				
SD03	ND				
SD04	ND				
SD05	ND				
SD06A	ND				
SD06B	ND				
SD07	ND				
SD08A	ND				
SD08B	ND				

Program Name and year(s) of study	Cadmium	Cadmium	Cadnium (STLC)	Cadmium (DIWET)	Cadmium (WET)
	mg/kg - wet	mg/kg - dry	mg/kg	mg/L	mg/L
SD09A	ND				
SD09B	ND				
SD10A	ND				
SD10B	ND				
SD11	ND				
SD12	ND				
SD13	ND				
Interim South Delta Program - 1994					
Count	18		12		
Min	ND		ND		
Max	ND		ND		
Average	N/A		N/A		
Standard Deviation	N/A		N/A		
Interim South Delta Program - 1996, dry					
Count	33			33	33
Min	0.00			0.00	0.00
Max	0.00			0.00	0.01
Average	0.00			0.00	0.00
Standard Deviation	0.00			0.00	0.00
Interim South Delta Program - 1996, wet					
Count	33			33	33
Min	0.00			0.00	0.00
Max	0.00			0.00	0.01
Average	0.00			0.00	0.00
Standard Deviation	0.00			0.00	0.00
San Francisco Estuary Institue, 1993-1995					
Pacheco Creek					
Count	6				
Min	0.07				
Max	0.16				
Average	0.11				

Program Name and year(s) of study	Cadmium	Cadmium	Cadnium (STLC)	Cadmium (DIWET)	Cadmium (WET)
	mg/kg - wet	mg/kg - dry	mg/kg	mg/L	mg/L
Standard Deviation	0.03				
Grizzly Bay					
Count	6				
Min	0.25				
Max	0.32				
Average	0.28				
Standard Deviation	0.03				
Honker Bay					
Count	4				
Min	0.26				
Max	0.41				
Average	0.33				
Standard Deviation	0.07				
Sacramento River @ Collinsville					
Count	6				
Min	0.13				
Max	0.32				
Average	0.23				
Standard Deviation	0.07				
San Joaquin River @ Antioch					
Count	6				
Min	0.15				
Max	0.22				
Average	0.19				
Standard Deviation	0.03				

Program Name and year(s) of study	Copper	Copper	Copper (STLC)	Copper (DIWET	Copper (WET)
	mg/kg - wet	mg/kg - dry	mg/kg	mg/L	mg/L
Interim North Delta Program - 1992					
ND01	41.00				
ND02	14.00				
ND03A	31.00				
ND03B	28.00				
ND04	6.00				
ND05	15.00				
ND06	5.00				
ND07	28.00				
ND08	13.00				
ND09A	11.00				
ND10	35.00				
ND11A	41.00				
ND11B	50.00				
ND12	49.00				
ND13A	18.00				
ND13B	6.60				
Interim North Delta Program - 1994					
Count	19	29		29	29
Min	23.00	0.00		ND	ND
Max	57.00	86.00		0.02	0.70
Average	39.00	58.87		0.01	0.36
Standard Deviation	9.98	21.61		0.01	0.25
Interim South Delta Program - 1992					
SD01	1.00				
SD02	28.00				
SD03	9.00				
SD04	21.00				
SD05	4.00				
SD06A	19.00				
SD06B	20.00				
SD07	19.00				
SD08A	23.00				
SD08B	6.00				

Program Name and year(s) of study	Copper	Copper	Copper (STLC)	Copper (DIWET	Copper (WET)
	mg/kg - wet	mg/kg - dry	mg/kg	mg/L	mg/L
SD09A	16.00				
SD09B	19.00				
SD10A	6.00				
SD10B	15.00				
SD11	26.00				
SD12	19.00				
SD13	15.00				
Interim South Delta Program - 1994					
Count	18		12		
Min	3.00		ND		
Max	33.00		ND		
Average	11.33		N/A		
Standard Deviation	8.94		N/A		
Interim South Delta Program - 1996, dry					
Count	33			33	33
Min	5.75			0.00	0.00
Max	52.44			0.09	0.42
Average	26.37			0.01	0.15
Standard Deviation	14.27			0.02	0.13
Interim South Delta Program - 1996, wet					
Count	33			33	33
Min	5.00			0.00	0.00
Max	43.00			0.06	0.39
Average	21.32			0.00	0.12
Standard Deviation	11.61			0.01	0.12
San Francisco Estuary Institue, 1993-1995					
Pacheco Creek					
Count	6				
Min	14.10				
Max	20.30				
Average	16.35				

Program Name and year(s) of study	Copper	Copper	Copper (STLC)	Copper (DIWET	Copper (WET)
	mg/kg - wet	mg/kg - dry	mg/kg	mg/L	mg/L
Standard Deviation	2.64				
Grizzly Bay					
Count	6				
Min	39.80				
Max	67.10				
Average	57.45				
Standard Deviation	9.86				
Honker Bay					
Count	4				
Min	45.30				
Max	71.90				
Average	62.20				
Standard Deviation	11.78				
Sacramento River @ Collinsville					
Count	6				
Min	20.70				
Max	42.30				
Average	26.86				
Standard Deviation	8.02				
San Joaquin River @ Antioch					
Count	6				
Min	24.43				
Max	39.70				
Average	32.42				
Standard Deviation	5.45				

Program Name and year(s) of study	Mercury	Mercury	Mercury (STLC)	Mercury (DIWET)	Mercury (WET)
	mg/kg - wet	mg/kg - dry	mg/kg	mg/L	mg/L
Interim North Delta Program - 1992					
ND01	0.17				
ND02	0.09				
ND03A	0.14				
ND03B	0.18				
ND04	ND				
ND05	0.06				
ND06	0.06				
ND07	0.09				
ND08	0.02				
ND09A	0.08				
ND10	0.10				
ND11A	0.13				
ND11B	0.18				
ND12	0.04				
ND13A	ND				
ND13B	ND				
Interim North Delta Program - 1994					
Count	18	29		29	29
Min	ND	ND		ND	ND
Max	0.48	0.74		0.00	ND
Average	0.20	0.31		n/a	n/a
Standard Deviation	0.09	0.16		n/a	n/a
Interim South Delta Program - 1992					
SD01	ND				
SD02	0.04				
SD03	0.04				
SD04	0.16				
SD05	ND				
SD06A	0.12				
SD06B	0.14				
SD07	0.12				
SD08A	0.10				
SD08B	0.04				

Program Name and year(s) of study	Mercury	Mercury	Mercury (STLC)	Mercury (DIWET)	Mercury (WET)
	mg/kg - wet	mg/kg - dry	mg/kg	mg/L	mg/L
SD09A	0.14				
SD09B	0.04				
SD10A	0.04				
SD10B	0.05				
SD11	0.02				
SD12	0.03				
SD13	0.07				
Interim South Delta Program - 1994					
Count	18		12		
Min	ND		0.01		
Max	ND		0.01		
Average	N/A		0.01		
Standard Deviation	N/A		0.00		
Interim South Delta Program - 1996, dry					
Count	33			33	33
Min	0.00			0.00	0.00
Max	0.12			0.00	0.00
Average	0.00			0.00	0.00
Standard Deviation	0.02			0.00	0.00
Interim South Delta Program - 1996, wet					
Count	33			33	33
Min	0.00			0.00	0.00
Max	0.10			0.00	0.00
Average	0.00			0.00	0.00
Standard Deviation	0.02			0.00	0.00
San Francisco Estuary Institue, 1993-1995					
Pacheco Creek					
Count	6				
Min	0.03				
Max	0.13				
Average	0.07				

Program Name and year(s) of study	Mercury	Mercury	Mercury (STLC)	Mercury (DIWET)	Mercury (WET)
	mg/kg - wet	mg/kg - dry	mg/kg	mg/L	mg/L
Standard Deviation	0.04				
Grizzly Bay					
Count	6				
Min	0.24				
Max	0.42				
Average	0.34				
Standard Deviation	0.06				
Honker Bay					
Count	4				
Min	0.30				
Max	0.45				
Average	0.35				
Standard Deviation	0.07				
Sacramento River @ Collinsville					
Count	6				
Min	0.06				
Max	0.15				
Average	0.10				
Standard Deviation	0.04				
San Joaquin River @ Antioch					
Count	6				
Min	0.09				
Max	0.42				
Average	0.26				
Standard Deviation	0.12				

Program Name and year(s) of study	Selenium	Selenium	Selenium (STLC)	Selenium (DIWET)	Selenium (WET)
	mg/kg - wet	mg/kg - dry	mg/kg	mg/L	mg/L
Interim North Delta Program - 1992					
ND01	ND				
ND02	ND				
ND03A	ND				
ND03B	ND				
ND04	ND				
ND05	ND				
ND06	ND				
ND07	ND				
ND08	ND				
ND09A	ND				
ND10	ND				
ND11A	ND				
ND11B	ND				
ND12	ND				
ND13A	ND				
ND13B	ND				
Interim North Delta Program - 1994					
Count	19	25		29	29
Min	ND	ND		ND	ND
Max	0.00	1.52		0.02	ND
Average	n/a	n/a		0.02	n/a
Standard Deviation	n/a	n/a		0.00	n/a
Interim South Delta Program - 1992					
SD01	ND				
SD02	ND				
SD03	ND				
SD04	ND				
SD05	ND				
SD06A	ND				
SD06B	ND				
SD07	ND				
SD08A	ND				
SD08B	ND				

Program Name and year(s) of study	Selenium	Selenium	Selenium (STLC)	Selenium (DIWET)	Selenium (WET)
	mg/kg - wet	mg/kg - dry	mg/kg	mg/L	mg/L
SD09A	ND				
SD09B	ND				
SD10A	ND				
SD10B	ND				
SD11	ND				
SD12	ND				
SD13	ND				
Interim South Delta Program - 1994					
Count	18		12		
Min	ND		ND		
Max	ND		ND		
Average	N/A		N/A		
Standard Deviation	N/A		N/A		
Interim South Delta Program - 1996, dry					
Count	33			33	33
Min	0.00			0.00	0.00
Max	2.00			0.00	0.00
Average	0.44			0.00	0.00
Standard Deviation	0.52			0.00	0.00
Interim South Delta Program - 1996, wet					
Count	33			33	33
Min	0.00			0.00	0.00
Max	1.60			0.00	0.00
Average	0.35			0.00	0.00
Standard Deviation	0.42			0.00	0.00
San Francisco Estuary Institue, 1993-1995					
Pacheco Creek					
Count	6				
Min	0.07				
Max	0.46				
Average	0.22				

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Program Name and year(s) of study	Selenium	Selenium	Selenium (STLC)	Selenium (DIWET)	Selenium (WET)
	mg/kg - wet	mg/kg - dry	mg/kg	mg/L	mg/L
Standard Deviation	0.18				
Grizzly Bay					
Count	6				
Min	0.21				
Max	3.30				
Average	0.95				
Standard Deviation	1.17				
Honker Bay					
Count	4				
Min	0.33				
Max	1.01				
Average	0.58				
Standard Deviation	0.30				
Sacramento River @ Collinsville					
Count	6				
Min	0.13				
Max	0.61				
Average	0.25				
Standard Deviation	0.19				
San Joaquin River @ Antioch					
Count	6				
Min	0.17				
Max	0.58				
Average	0.39				
Standard Deviation	0.18				

Program Name and year(s) of study	Zinc	Zinc	Zinc (STLC)	Zinc (DIWET)	Zinc (WET)
	mg/kg - wet	mg/kg - dry	mg/kg	mg/L	mg/L
Interim North Delta Program - 1992					
ND01	91.00				
ND02	130.00				
ND03A	68.00				
ND03B	45.00				
ND04	6.00				
ND05	30.00				
ND06	19.00				
ND07	82.00				
ND08	60.00				
ND09A	42.00				
ND10	84.00				
ND11A	110.00				
ND11B	120.00				
ND12	89.00				
ND13A	86.00				
ND13B	51.00				
Interim North Delta Program - 1994					
Count	15	25		29	29
Min	2.50	ND		ND	0.22
Max	89.00	160.00		0.26	16.00
Average	55.90	94.29		0.11	2.17
Standard Deviation	27.17	46.38		0.13	2.78
Interim South Delta Program - 1992					
SD01	7.00				
SD02	59.00				
SD03	23.00				
SD04	41.00				
SD05	12.00				
SD06A	40.00				
SD06B	35.00				
SD07	37.00				
SD08A	51.00				
SD08B	16.00				

Program Name and year(s) of study	Zinc	Zinc	Zinc (STLC)	Zinc (DIWET)	Zinc (WET)
	mg/kg - wet	mg/kg - dry	mg/kg	mg/L	mg/L
SD09A	37.00				
SD09B	38.00				
SD10A	19.00				
SD10B	36.00				
SD11	51.00				
SD12	42.00				
SD13	33.00				
Interim South Delta Program - 1994					
Count	18		12		
Min	10.00		0.10		
Max	62.00		0.30		
Average	31.78		0.17		
Standard Deviation	13.93		0.09		
Interim South Delta Program - 1996, dry					
Count	33			33	33
Min	22.62			0.00	0.08
Max	98.78			0.42	2.66
Average	56.14			0.04	0.94
Standard Deviation	21.97			0.08	0.67
Interim South Delta Program - 1996, wet					
Count	33			33	33
Min	19.00			0.00	0.07
Max	81.00			0.35	2.10
Average	45.15			0.03	0.76
Standard Deviation	17.21			0.06	0.55
San Francisco Estuary Institue, 1993-1995					
Pacheco Creek					
Count	6				
Min	54.38				
Max	72.00				
Average	63.88				

Program Name and year(s) of study	Zinc	Zinc	Zinc (STLC)	Zinc (DIWET)	Zinc (WET)
	mg/kg - wet	mg/kg - dry	mg/kg	mg/L	mg/L
Standard Deviation	5.76				
Grizzly Bay					
Count	6				
Min	94.00				
Max	151.50				
Average	128.15				
Standard Deviation	19.49				
Honker Bay					
Count	4				
Min	116.00				
Max	165.00				
Average	136.25				
Standard Deviation	20.61				
Sacramento River @ Collinsville					
Count	6				
Min	72.62				
Max	114.00				
Average	85.19				
Standard Deviation	15.00				
San Joaquin River @ Antioch					
Count	6				
Min	61.00				
Max	78.60				
Average	69.36				
Standard Deviation	6.90				

Program Name and year(s) of study	Chlordane	Total DDT	Toxaphene	Total PCBs	pH	TOC
	ug/kg	ug/kg	ug/kg	ug/kg		mg/kg
Interim North Delta Program - 1992						
ND01	ND	ND	ND		6.80	
ND02	ND	ND	ND		7.00	
ND03A	ND	ND	ND		6.90	
ND03B	ND	ND	ND		7.10	
ND04	ND	ND	ND		6.40	
ND05	ND	ND	ND		6.00	
ND06	ND	ND	ND		5.90	
ND07	ND	ND	ND		6.50	
ND08	ND	ND	ND		6.80	
ND09A	ND	ND	ND		7.00	
ND10	ND	ND	ND		7.40	
ND11A	ND	ND	ND		6.90	
ND11B	ND	ND	ND		7.80	
ND12	ND	ND	ND		7.80	
ND13A	ND	ND	ND		6.30	
ND13B	ND	ND	ND		6.60	
Interim North Delta Program - 1994						
Count				29	28	29
Min				ND	6.50	2727.27
Max				ND	8.20	22388.06
Average				n/a	7.06	11012.79
Standard Deviation				n/a	0.50	4358.51
Interim South Delta Program - 1992						
SD01	ND	ND	ND		7.50	
SD02	ND	ND	ND		8.70	
SD03	ND	ND	ND		8.00	
SD04	ND	ND	ND		6.40	
SD05	ND	ND	ND		7.80	
SD06A	ND	ND	ND		7.00	
SD06B	ND	ND	ND		6.80	
SD07	ND	ND	ND		6.50	
SD08A	ND	ND	ND		6.20	
SD08B	ND	ND	ND		6.60	

Program Name and year(s) of study	Chlordane	Total DDT	Toxaphene	Total PCBs	pH	TOC
	ug/kg	ug/kg	ug/kg	ug/kg		mg/kg
SD09A	ND	ND	ND		6.10	
SD09B	ND	ND	ND		6.80	
SD10A	ND	ND	ND		7.30	
SD10B	ND	ND	ND		7.00	
SD11	ND	ND	ND		7.30	
SD12	ND	ND	ND		7.00	
SD13	ND	ND	ND		6.70	
Interim South Delta Program - 1994						
Count	18	36	12	126	6	
Min	ND	ND	ND	ND	7.10	
Max	ND	ND	ND	ND	8.30	
Average	N/A	N/A	N/A	N/A	7.82	
Standard Deviation	N/A	N/A	N/A	N/A	0.43	
Interim South Delta Program - 1996, dry						
Count	33	33	33		33	33
Min	0.00	0.00	0.00		8.00	471.26
Max	0.00	0.00	0.00		11.01	62857.14
Average	0.00	0.00	0.00		9.47	6691.20
Standard Deviation	0.00	0.00	0.00		0.87	12340.52
Interim South Delta Program - 1996, wet						
Count	33	33	33		33	33
Min	0.00	0.00	0.00		6.80	410.00
Max	0.00	0.00	0.00		8.90	44000.00
Average	0.00	0.00	0.00		7.65	4903.33
Standard Deviation	0.00	0.00	0.00		0.50	8578.94
San Francisco Estuary Institue, 1993-1995	ng/g	ng/g		ng/g		
Pacheco Creek						
Count	5	5		5		
Min	0.00	0.00		0.70		
Max	1.13	2.62		4.83		
Average	0.25	0.91		2.10		

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Program Name and year(s) of study	**Chlordane**	**Total DDT**	**Toxaphene**	**Total PCBs**	**pH**	**TOC**
	ug/kg	**ug/kg**	**ug/kg**	**ug/kg**		**mg/kg**
Standard Deviation	0.49	1.08		1.78		
Grizzly Bay						
Count	1	5		5		
Min	BDL	0.33		1.00		
Max	0.33	10.40		17.77		
Average	0.33	4.06		6.58		
Standard Deviation	n/a	3.98		6.79		
Honker Bay						
Count	1	4		4		
Min	BDL	1.67		3.00		
Max	0.63	6.96		12.99		
Average	0.63	4.29		7.50		
Standard Deviation	n/a	2.16		4.20		
Sacramento River @ Collinsville						
Count	1	5		5		
Min	BDL	0.15		0.00		
Max	0.15	2.08		10.80		
Average	0.15	0.98		2.92		
Standard Deviation	n/a	0.76		4.44		
San Joaquin River @ Antioch						
Count	1	5		5		
Min	BDL	0.00		0.00		
Max	0.17	0.88		2.70		
Average	0.17	0.25		1.17		
Standard Deviation	n/a	0.36		0.98		

APPENDIX C

SUPPLEMENTAL INFORMATION PERTAINING TO PARAMETER LOADING TABLES

Bromide Loading Notes

a. Concentration data was received from Ray Tom of the Department of Water Resources. Concentrations data was collected at Green's Landing for the Sacramento River and Vernalis for the San Joaquin River. Flow data is from USGS Water Data Reports for the years in which concentration data was available.

Loads were calculated for each day data were available. For the period of record the average daily load was calculated from all the daily values. The annual load for the period of record is the product of the average daily load multiplied times the number of seconds in a year. The resulting value was converted to an average annual value by dividing the annual load for the period of record by the average daily flow over the period of record and then multiplying the result times the long term daily average flow rate.

average annual load = ((average daily load * number of seconds in a year) / average daily flow over the period of record)* long term daily average flow rate

b. See note a for explanation.

Cadmium Loading Notes

a. The original data for the load estimate was obtained from "A mass loading assessment of major point and non-point sources discharging to surface waters in the Central Valley, California, 1985" prepared by the RWQCB Central Valley Region in 1988. Flow and load data was compiled for four inactive mines including Iron Mountain, Newton, New Idria and Afterthought Mines. Only mines that drain to the Sacramento River or its tributaries below Shasta, Oroville and Nimbus Dams were considered. Eighty-five percent of the load was from Iron Mountain. A later report by Central Valley RWQCB prepared in 1989 and entitled "A mass loading assessment of major point and non-point sources in the Sacramento Valley, California, 1985" estimated that the earlier mine drainage estimate only represented 25% of the total. A further review of the two RWQCB documents was made by Woodward-Clyde in light of information contained in a 1992 report by the Central Valley Board entitled "Inactive mine drainage in the Sacramento Valley". Data in this report suggests that mine drainage represents about 50% of the total cadmium load from inactive mines. The 50% estimate was used to scale up the loads originally calculated by RWQCB. The loads calculated in the 1988 RWQCB were segregated into the three geographical areas, delta, San Joaquin Basin and Sacramento Basin below dams.

b. The original data for the load estimate was obtained from "A mass loading assessment of major point and non-point sources discharging to surface waters in the Central Valley, California, 1985" prepared by the RWQCB Central Valley Region in 1988. Flow and load data was compiled from several NPDES dischargers who have been monitoring copper. including the largest in the Central Valley the Sacramento Regional County Sewer District. Woodward-Clyde divided the results into two geographical areas, the delta and the Sacramento Basin. A later report by Central Valley RWQCB prepared in 1989 and entitled "A mass loading assessment of major point and non-point sources in the Sacramento Valley, California, 1985" estimated that the earlier M and I estimate only represented 50% of the total. This percentage was used to scale up the loads.

c. The original data for the load estimate was obtained from "A mass loading assessment of major point and non-point sources discharging to surface waters in the Central Valley, California, 1985" prepared by the RWQCB Central Valley Region in 1988. Urban runoff estimates were made for 19 large cities in the Central Valley. Flow data was calculated using rainfall data for cities, urban acreage and a runoff factor of 0.3. Quality data for the city of Sacramento was used for all cities. A later report by Central Valley RWQCB prepared in 1989 and entitled "A mass loading assessment of major point and non-point sources in the Sacramento Valley, California, 1985" estimated that the earlier urban runoff estimate only represented 35% of the total. A further review of the original data by Woodward-Clyde concluded that the original estimate probably captured 70% of the load, because all major urban areas were included in the calculations. The 70% figure was used to scale up the original estimates. The data allowed separation of the loads into three geographical areas, the delta, San Joaquin Basin and the Sacramento Basin.

d. The original data for the load estimate was obtained from "A mass loading assessment of major point and non-point sources discharging to surface waters in the Central Valley, California, 1985" prepared by the RWQCB Central Valley Region in 1988. Flow and concentration information was compiled for the major drains in the Sacramento Basin, including Sacramento Slough, Colusa Basin Drain, RD1000, RD108 and Natomas East Main Drain. A later report by Central Valley RWQCB prepared in 1989 and entitled "A mass loading assessment of major point and non-point sources in the Sacramento Valley, California, 1985" estimated that the earlier agricultural runoff estimate only represented 80% of the total. This percentage was used to scale up the estimates.

e. See note a for explanation.

f. See note b for explanation.

g. See note c for explanation.

h. Concentration data is from EarthInfo USGS Quality of Water databases on CD-ROM (EarthInfo, 1996). Flow data is from USGS Water Data Reports for the years in which concentration data was available. For the Sacramento River concentration and flow data used in the load calculation is from Freeport. For the San Joaquin River concentration and flow data used in the load calculation is from Vernalis.

Loads were calculated for each day data were available. For the period of record the average daily load was calculated from all the daily values. The annual load for the period of record is the product of the average daily load multiplied times the number of seconds in a year. The resulting value was converted to an average annual value by dividing the annual load for the period of record by the average daily flow over the period of record and then multiplying the result times the long term daily average flow rate.

average annual load = ((average daily load * number of seconds in a year) / average daily flow over the period of record)* long term daily average flow rate.

i. See Note a for explanation.

j. See Note b for explanation.

k. See Note c for explanation.

l. See Note h for explanation.

m. Reported in Table 19 of "State of the Estuary: A report on conditions and problems in San Francisco Bay/Sacramento-San Joaquin Delta Estuary' San Francisco Estuary Project, 1992. Middle of range of values used .

n. See Note mc for explanation.

o. Total emission from upper Sacramento Basin was calculated using flow and concentration data for releases from Shasta, Oroville and Nimbus Dams. Reported in "A mass loading assessment of major point and non-point sources discharging to surface waters in the Central Valley, California, 1985" prepared by the RWQCB Central Valley Region in 1988.

Copper Loading Notes

a. The original data for the load estimate was obtained from "A mass loading assessment of major point and non-point sources discharging to surface waters in the Central Valley, California, 1985" prepared by the RWQCB Central Valley Region in 1988. Flow and load data was compiled for four inactive mines including Iron Mountain, Newton, New Idria and Afterthought Mines. Only mines that drain to the Sacramento River or its tributaries below Shasta, Oroville and Nimbus Dams were considered. Ninety-five percent of the load was from Iron Mountain. A later report by Central Valley RWQCB prepared in 1989 and entitled "A mass loading assessment of major point and non-point sources in the Sacramento Valley, California, 1985" estimated that the earlier mine drainage estimate only represented 25% of the total. A further review of the two RWQCB documents was made by Woodward-Clyde in light of information contained in a 1992 report by the Central Valley Board entitled "Inactive mine drainage in the Sacramento Valley". Data in this report suggests that Iron Mountain represents about 50% of the total copper load from inactive mines. The 50% estimate was used to scale up the loads originally calculated by RWQCB. The loads calculated in the 1988 RWQCB were segregated into the three geographical areas, delta, San Joaquin Basin and Sacramento Basin below dams.

b. The original data for the load estimate was obtained from "A mass loading assessment of major point and non-point sources discharging to surface waters in the Central Valley, California, 1985" prepared by the RWQCB Central Valley Region in 1988. Flow and load data was compiled from several NPDES dischargers who have been monitoring copper. including the largest in the Central Valley the Sacramento Regional County Sewer District. Woodward-Clyde divided the results into two geographical areas, the delta and the Sacramento Basin. A later report by Central Valley RWQCB prepared in 1989 and entitled "A mass loading assessment of major point and non-point sources in the Sacramento Valley, California, 1985" estimated that the earlier M and I estimate only represented 50% of the total. This percentage was used to scale up the loads.

c. The original data for the load estimate was obtained from "A mass loading assessment of major point and non-point sources discharging to surface waters in the Central Valley, California, 1985" prepared by the RWQCB Central Valley Region in 1988. Urban runoff estimates were made for 19 large cities in the Central Valley. Flow data was calculated using rainfall data for cities, urban acreage and a runoff factor of 0.3. Quality data for the city of Sacramento was used for all cities. A later report by Central Valley RWQCB prepared in 1989 and entitled "A mass loading assessment of major point and non-point sources in the Sacramento Valley, California, 1985" estimated that the earlier urban runoff estimate only represented 35% of the total. A further review of the original data by Woodward-Clyde concluded that the original estimate probably captured 70% of the load, because all major urban areas were included in the calculations. The 70% figure was used to scale up the original estimates. The data allowed separation of the loads into three geographical areas, the delta, San Joaquin Basin and the Sacramento Basin.

d. Copper concentrations are available from various sampling locations within the Delta and at the San Joaquin River inflow to the Delta. Most of this data can be found at the Interagency Ecological Program web site. Work is in progress to acquire matching discharge data and calculate loads.

e. The original data for the load estimate was obtained from "A mass loading assessment of major point and non-point sources discharging to surface waters in the Central Valley, California, 1985" prepared by the RWQCB Central Valley Region in 1988. Flow and concentration information was compiled for the major drains in the Sacramento Basin, including Sacramento Slough, Colusa Basin Drain, RD1000, RD108 and Natomas East Main Drain. A later report by Central Valley RWQCB prepared in 1989 and entitled "A mass loading assessment of major point and non-point sources in the Sacramento Valley, California, 1985" estimated that the earlier agricultural runoff estimate only represented 80% of the total. This percentage was used to scale up the estimates.

f. See Note a for explanation.

g. See Note b for explanation.

h. See Note c for explanation.

i. Concentration data is from EarthInfo USGS Quality of Water databases on CD-ROM (EarthInfo, 1996). Flow data is from USGS Water Data Reports for the years in which concentration data was available. For the Sacramento River concentration and flow data used in the load calculation is from Freeport. For the San Joaquin River concentration and flow data used in the load calculation is from Vernalis.

Loads were calculated for each day data were available. For the period of record the average daily load was calculated from all the daily values. The annual load for the period of record is the product of the average daily load multiplied times the number of seconds in a year. The resulting value was converted to an average annual value by dividing the annual load for the period of record by the average daily flow over the period of record and then multiplying the result times the long term daily average flow rate.

average annual load = ((average daily load * number of seconds in a year) / average daily flow over the period of record)* long term daily average flow rate

j. See Note a for explanation.

k. See Note c for explanation.

l. See Note i for explanation.

m. Reported in Table 19 of "State of the Estuary: A report on conditions and problems in San Francisco Bay/Sacramento-San Joaquin Delta Estuary' San Francisco Estuary Project, 1992. Middle of range of values used .

Copper Loading Notes

n. See Note m for explanation.

o. Total emission from upper Sacramento Basin was calculated using flow and concentration data for releases from Shasta, Oroville and Nimbus Dams. Reported in "A mass loading assessment of major point and non-point sources discharging to surface waters in the Central Valley, California, 1985" prepared by the RWQCB Central Valley Region in 1988.

Dissolved Organic Carbon (DOC) Loading Notes

a. Load data was obtained from the "Study of Drinking Water Quality in Delta Tributaries" from the California Urban Water Agencies, April 1995 Report. The data estimated using Figure 4-1 which shows total loads of DOC and TOC and percentages for various contributing sources. The total in pounds per day in the Sacramento River at Greene's Landing is 310,000 lbs/day, 13.75 % of that is from agriculture. The data were evaluated using two techniques. One involves constructing and evaluating time-series plots for rainfall, flow, concentration and load allowing for a directs and detailed examination of seasonal and historical patterns and allow for a direct and detailed examination of periods when concentrations are high. The second technique included combining data from different sets of conditions/types of seasonal periods to average loads.

b. The "Study of Drinking Water Quality in Delta Tributaries", California Urban Water Agencies, April 1995 shows a 1.1 mg/L increase in DOC concentrations from agricultural drainage by comparing Inflow, Observed and Predicted DOC Five Years (1987-91) of Monthly Average DOC data. No flow data was supplied, therefore, no load calculations can be performed until further literature review has been performed.

c. A single sample reported in the Study of Drinking Water Quality in Delta Tributaries. California Urban Water Agencies, April 1995, was collected in 1989 (4.4-500mg/l) for urban runoff in Sacramento. No flow data available for this sample. Further data search must be performed to obtain additional TOC data information for load calculations.

Mercury Loading Notes

a. Concentration data is from EarthInfo USGS Quality of Water databases on CD-ROM (EarthInfo, 1996). Flow data is from USGS Water Data Reports for the years in which concentration data was available. For the Sacramento River concentration and flow data used in the load calculation is from Freeport. For the San Joaquin River concentration and flow data used in the load calculation is from Vernalis.

Loads were calculated for each day data were available. For the period of record the average daily load was calculated from all the daily values. The annual load for the period of record is the product of the average daily load multiplied times the number of seconds in a year. The resulting value was converted to an average annual value by dividing the annual load for the period of record by the average daily flow over the period of record and then multiplying the result times the long term daily average flow rate.

average annual load = ((average daily load * number of seconds in a year) / average daily flow over the period of record)* long term daily average flow rate

b. See Note a for explanation.

c. Reported in Table 19 of "State of the Estuary: A report on conditions and problems in San Francisco Bay/Sacramento-San Joaquin Delta Estuary' San Francisco Estuary Project, 1992. Middle of range of values used .

d. See Note c for explanation.

e. Emission was calculated using flow and concentration data for release from Shasta Dam. No similar data was available for Oroville and Nimbus Dams so this is probably an underestimate. Reported in "A mass loading assessment of major point and non-point sources discharging to surface waters in the Central Valley, California, 1985" prepared by the RWQCB Central Valley Region in 1988. The emission is the product of a large flow and a small concentration, probably based on limited data. Consequently, a small error in concentration can greatly effect the emission rate.

Nitrate Loading Notes

a. Nitrate loads were calculated by Woodward-Clyde for the Contra Costa Clean Water Program (Contra Costa Clean Water Program, 1994). The loads assessment model is based upon a relationship between rainfall quantities, runoff pollutant concentrations, and the relationship between pollutant loads and land use. The loads assessment model contains the following assumptions:

- Uniform precipitation between isohyets
- Constant runoff coefficient based upon land use
- Runoff water quality was constant for each land use
- Isohyetals based on average annual precipitation

The reported load in the loading table is from Figure 4-1 of the report (Contra Costa Clean Water Program, 1994).

b. See Note a for explanation.

c. Nitrate loads were calculated for the Sacramento NPDES Stormwater Discharge Characterization Program (Larry Walker & Associates). Loads were initially calculated in 1992 using the following methodology:

- Regression models were developed showing the relationship of urban runoff pollutant discharge factors.
- The regression equations were then used as input to a continuous simulation model for Sacramento urban runoff mass loading over a 58 year period.
- The model was refined in 1996, using the updated database of urban runoff monitoring data available form the Sacramento NPDES Stormwater Monitoring Program. the load reported in the loading table is from Table 15 of the report (Larry Walker & Associates).

Selenium Loading Notes

a. Concentration data is from EarthInfo USGS Quality of Water databases on CD-ROM (EarthInfo, 1996). Flow data is from USGS Water Data Reports for the years in which concentration data was available. For the Sacramento River concentration and flow data used in

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the load calculation is from Freeport. For the San Joaquin River concentration and flow data used in the load calculation is from Vernalis.

Loads were calculated for each day data were available. For the period of record the average daily load was calculated from all the daily values. The annual load for the period of record is the product of the average daily load multiplied times the number of seconds in a year. The resulting value was converted to an average annual value by dividing the annual load for the period of record by the average daily flow over the period of record and then multiplying the result times the long term daily average flow rate.

average annual load = ((average daily load * number of seconds in a year) / average daily flow over the period of record)* long term daily average flow rate

b. See Note a for explanation.

c. Selenium loads to San Francisco Bay are reported in "Mass Emissions Reduction Strategy for Selenium" prepared by San Francisco Bay RWQCB in 1992. The loads are estimated as 7.1 kg/day from oil refineries, 2.2 kg/day from municipal wastewater treatment plants and 2 kg/day from riverine sources under average flow conditions. No selenium was detected in samples of municipal wastewater. The RWQCB assumed that it was present in municipal wastewater at the detection limit used in the analyses and thus calculated 2.2 kg/day. The RWQCB noted this was a probable overstatement. It is worth noting that the estimated load to the bay from riverine sources (1,600 lbs/yr) is much lower than the sum of the Sacramento and San Joaquin River inputs to the Bay-Delta system (11,000 lbs/yr reported in "State of the Estuary: A report on conditions and problems in San Francisco Bay/Sacramento-San Joaquin Delta Estuary" San Francisco Estuary Project, 1992. Perhaps, this is attributable chemical reactions and biological uptake in the Delta.

Total Dissolved Solids (TDS) Loading Notes

a. One study on drinking water quality in Delta tributaries calculated the relative proportions of TDS loads in the Sacramento River at Greene's Landing (California Urban Water Agencies, 1995). The load was subdivided into the following five categories: other sources, Sacramento Regional Wastewater Treatment Plant, Sacramento Combined Sewer Overflow, urban runoff, and the Sacramento Slough and Colusa Basin Drain. The load from Sacramento Slough and Colusa Basin Drain is assumed to be drainage from rice fields and therefore represents the agricultural load for the Lower Sacramento Basin.. The study calculated loads for both wet and dry years. The table contains an average for both years.

b. The portion of the load attributed to the Sacramento Regional Wastewater Treatment Plant in the drinking water study referenced in note represents a load from the area serviced by the plant. The load in the table does not represent a total load form all POTW's in the Lower Sacramento River Basin. The load value in the table is an average of wet and dry year loads.

c. The TDS concentration was developed from a continuous simulation analysis as a sum of the loads from wet weather, dry season and inter-storm loads (Larry Walker & Associates, 1996).

d. Concentration data was received from Ray Tom of the Department of Water Resources. Concentrations data was collected at Green's Landing for the Sacramento River and Vernalis for the San Joaquin River. Flow data is from USGS Water Data Reports for the years in which concentration data was available.

Loads were calculated for each day data were available. For the period of record the average daily load was calculated from all the daily values. The annual load for the period of record is the product of the average daily load multiplied times the number of seconds in a year. The resulting value was converted to an average annual value by dividing the annual load for the period of record by the average daily flow over the period of record and then multiplying the result times the long term daily average flow rate.

average annual load = ((average daily load * number of seconds in a year) / average daily flow over the period of record)* long term daily average flow rate

e. The study referenced in note a above also calculated loads for the San Joaquin River at Vernalis. The load was subdivided into contributions from Mud and Salt Sloughs and other sources. The load from Mud and Salt Sloughs is assumed to be agricultural drainage. The load value in the table is an average of wet and dry year loads.

f. One study (Fresno Metropolitan Flood Control District, 1995) estimated the annual pollutant loads, summing the loads from the San Joaquin River, Dry Creek and Bidon Canal.

g. See explanation for note d.

Total Organic Carbon (TOC) Loading Notes

a. Load concentrations to the mud and salt sloughs from agriculture in the Sacramento Area were reported in the "Study of Drinking Water Quality in Delta Tributaries". (California Urban Water Agencies,1995). The value was obtained from Appendix D, Table D-7. The value used here is the highest value from the Table and in Wet year/wet season. The annual load was calculated assuming an average of 30,850 lb/day and 365 days in the wet season as defined in the study.

b. Load data was obtained from the "Study of Drinking Water Quality in Delta Tributaries" from the California Urban Water Agencies, April 1995 Report. The data estimated using Figure 4-1 which shows total loads of DOC and TOC and percentages for various contributing sources. The total in pounds per day in the Sacramento River at Greene's Landing is 310,000 lbs/day, 4.75 % of that is from agriculture. The data were evaluated using two techniques. one involves constructing and evaluating time-series plots for rainfall, flow, concentration and load allowing for a directs and detailed examination of seasonal and historical patterns and allow for a direct and detailed examination of periods when concentrations are high. The second technique included combining data from different sets of conditions/types of seasonal periods to average loads.

c. Concentration data was received from Ray Tom of the Department of Water Resources. Concentrations data was collected at Green's Landing for the Sacramento River and Vernalis for the San Joaquin River. Flow data is from USGS Water Data Reports for the years in which concentration data was available.

Loads were calculated for each day data were available. For the period of record the average daily load was calculated from all the daily values. The annual load for the period of record is the product of the average daily load multiplied times the number of seconds in a year. The resulting value was converted to an average annual value by dividing the annual load for the period of record by the average daily flow over the period of record and then multiplying the result times the long term daily average flow rate.

average annual load = ((average daily load * number of seconds in a year) / average daily flow over the period of record)* long term daily average flow rate

d. Load data was obtained from the "Study of Drinking Water Quality in Delta Tributaries" from the California Urban Water Agencies, April 1995 Report. The data estimated using Figure 4-1 which shows total loads of DOC and TOC and percentages for various contributing sources. The total in pounds per day in the San Joaquin River at Vernalis is 47,950 lbs/day, 61.51 % of that is from agriculture. The data were evaluated using two techniques. One involves constructing and evaluating time-series plots for rainfall, flow, concentration and load allowing for a directs and detailed examination of seasonal and historical patterns and allow for a direct and detailed examination of periods when concentrations are high. The second technique included combining data from different sets of conditions/types of seasonal periods to average loads.

Additional sampling has been conducted by the Department of Pesticide Regulations along the San Joaquin River. Sampling occurred periodically from March of 1991 through February of 1993. It can be assumed that these samples are being collected to estimate contaminants from agriculture. Concentration and flow data are available for values collected in the San Joaquin River. Further Investigation on the locations of these monitoring stations and surrounding landuse will be performed prior to load calculations.

e. Concentration data is from EarthInfo USGS Quality of Water databases on CD-ROM (EarthInfo, 1996). Flow data is from USGS Water Data Reports for the years in which concentration data was available. For the Sacramento River concentration and flow data used in the load calculation is from Freeport. For the San Joaquin River concentration and flow data used in the load calculation is from Vernalis.

Loads were calculated for each day data were available. For the period of record the average daily load was calculated from all the daily values. The annual load for the period of record is the product of the average daily load multiplied times the number of seconds in a year. The resulting value was converted to an average annual value by dividing the annual load for the period of record by the average daily flow over the period of record and then multiplying the result times the long term daily average flow rate.

The load was calculated using the equation in note c.

Zinc Loading Notes

a. The original data for the load estimate was obtained from "A mass loading assessment of major point and non-point sources discharging to surface waters in the Central Valley, California, 1985" prepared by the RWQCB Central Valley Region in 1988. Flow and load data was compiled for four inactive mines including Iron Mountain, Newton, New Idria and Afterthought Mines. Only mines that drain to the Sacramento River or its tributaries below Shasta, Oroville and Nimbus Dams were considered. Eighty-five percent of the load was from Iron Mountain. A later report by Central Valley RWQCB prepared in 1989 and entitled "A mass loading assessment of major point and non-point sources in the Sacramento Valley, California, 1985" estimated that the earlier mine drainage estimate only represented 25% of the total. A further review of the two RWQCB documents was made by Woodward-Clyde in light of information contained in a 1992 report by the Central Valley Board entitled "Inactive mine drainage in the Sacramento Valley". Data in this report suggests that mine drainage represents about 50% of the total zinc load from inactive mines. The 50% estimate was used to scale up the loads originally calculated by RWQCB. The loads calculated in the 1988 RWQCB were segregated into the three geographical areas, delta, San Joaquin Basin and Sacramento Basin below dams.

b. The original data for the load estimate was obtained from "A mass loading assessment of major point and non-point sources discharging to surface waters in the Central Valley, California, 1985" prepared by the RWQCB Central Valley Region in 1988. Flow and load data was compiled from several NPDES dischargers who have been monitoring copper. including the largest in the Central Valley the Sacramento Regional County Sewer District. Woodward-Clyde divided the results into two geographical areas, the delta and the Sacramento Basin. A later report by Central Valley RWQCB prepared in 1989 and entitled "A mass loading assessment of major point and non-point sources in the Sacramento Valley, California, 1985" estimated that the earlier M and I estimate only represented 50% of the total. This percentage was used to scale up the loads.

c. Loads were taken from "A mass loading assessment of major point and non-point sources discharging to surface waters in the Central Valley, California, 1985" prepared by the RWQCB Central Valley Region in 1989.

d. See note a for explanation.

e. See note c for explanation.

f. See note c for explanation.

g. Concentration data is from EarthInfo USGS Quality of Water databases on CD-ROM (EarthInfo, 1996). Flow data is from USGS Water Data Reports for the years in which concentration data was available. For the Sacramento River concentration and flow data used in the load calculation is from Freeport. For the San Joaquin River concentration and flow data used in the load calculation is from Vernalis.

Loads were calculated for each day data were available. For the period of record the average daily load was calculated from all the daily values. The annual load for the period of record is the product of the average daily load multiplied times the number of seconds in a year. The resulting value was converted to an average annual value by dividing the annual load for the period of record by the average daily flow over the period of record and then multiplying the result times the long term daily average flow rate.

average annual load = ((average daily load * number of seconds in a year) / average daily flow over the period of record)* long term daily average flow rate.

h. See note a for explanation.

i. See note g for explanation.

j. Estimate of Bay Region loads were made by adding estimated pollutant loads of Contra Costa, Alameda and Santa Clara Counties. This value probably underestimates the total contribution of zinc by the Bay Region.

FURTHER RESEARCH REQUIRED TO ALLOCATE LOADS

Carbofuran Loading Notes

General Notes

- Applied to alfalfa fields in March and to rice fields from April through June.

a. Several studies report carbofuran concentrations detected in the Sacramento River at various locations (USGS, 1995, Open File Report 95-110); (Crepeau et. al.); (Department of Fish and Game, Rice Pesticide Concentrations in the Sacramento River and Associated Agricultural Drains); (Department of Water Resources, August 1989). Discharge data is available for many of the locations where carbofuran was sampled. Load calculations are in progress.

b. See Note a for explanation.

Chlorpyrifos Loading Notes

General Notes

- Applied to almond orchards in January and February and again in May through August.
- Applied to alfalfa fields in March.

- Particle bound compound.

a. Concentration data is from EarthInfo USGS Quality of Water databases on CD-ROM (EarthInfo, 1996). Flow data is from USGS Water Data Reports for the years in which concentration data was available. For the Sacramento River concentration and flow data used in the load calculation is from Freeport. For the San Joaquin River concentration and flow data used in the load calculation is from Vernalis.

Loads were calculated for each day data were available. For the period of record the average daily load was calculated from all the daily values. The annual load for the period of record is the product of the average daily load multiplied times the number of seconds in a year. The resulting value was converted to an average annual value by dividing the annual load for the period of record by the average daily flow over the period of record and then multiplying the result times the long term daily average flow rate.

average annual load = ((average daily load * number of seconds in a year) / average daily flow over the period of record)* long term daily average flow rate.

Diazinon Loading Notes

General Notes

- Applied to almond orchards in January and February and again in May through August.
- Applied to alfalfa fields in March.

a. One study (Conner, 1996) reports diazinon concentrations in urban runoff from the cities of Stockton and Sacramento and the San Francisco Bay Area. The concentration from the City of Stockton could be used to calculate a load for the Delta. However, further investigation is required to determine if discharge data can be matched to the sampling events and locations.

b. See Note a for explanation.

c. Loads were estimated based on measured diazinon concentrations and measured streamflows. Diazinon concentrations in the San Joaquin River at Vernalis were obtained from The USGS WATSTOR database and the USGS Open File Report 95-110. Diazinon data in the Sacramento River at Sacramento were obtained from the USGS Open File Report 95-110. Flows in the Sacramento River are from the USGS gage at Freeport (#11447650).

d. Flows in the San Joaquin River are from the USGS gage at Vernalis (#11303500). At Vernalis loads were estimated for years 1991, 1993, and 1994. The average is reported in the table. At Sacramento loads were estimated for 1993 and 1994 and the average reported. Note, the estimated diazinon load at Sacramento includes urban runoff from Sacramento and surrounding areas in addition to agricultural runoff. Non-detect data was not included in the loads analysis.

APPENDIX D

SECTION 303(d) LIST INFORMATION

Clean Water Act Section 303(d) Listed Impaired Waterbodies Within the CALFED Problem Area

Waterbody	Regional Board	Parameters of Concern	Probable Sources
Delta			
Carquinez Strait	2	Metals	Municipal and Industrial Point Sources, Mining, Urban
Delta Waterways	5	Mercury Diazinon, Chlorpyrifos Group A Pesticides (Chlordane, Toxaphene) Unknown Toxicity DDT Dissolved Oxygen Salt	Mining Agriculture, Urban Agriculture Unknown Agriculture Municipal, Urban Agriculture
Lone Tree Creek	5	Ammonia, Salt, DO	Dairies
Marsh Creek	5	Mercury	Mining
Suisun Bay	2	Metals	Municipal and Industrial Point Sources, Mining, Urban
Suisun Marsh Wetlands	2	Metals Nutrients Salinity Dissolved Oxygen	Agriculture, Urban, Flow Regulation Agriculture, Urban, Flow Regulation Agriculture, Urban, Flow Regulation Agriculture, Urban, Flow Regulation

Note: These waterbodies represent CWA Section 303(d) impaired waterbodies within the CALFED problem area that are impaired due to the presence of one or more CALFED Water Quality parameters of concern.

303D.XLS
CALFED problem area
8/4/97

Clean Water Act Section 303(d) Listed Impaired Waterbodies
Within the CALFED Solution Area

Waterbody	Regional Board	Parameters of Concern	Probable Sources
Sacramento River Basin			
American River, Lower	5	Mercury Group A Pesticides (Chlordane) Unknown Toxicity	Mining Urban Unknown
Cache Creek	5	Mercury Unknown Toxicity	Mining Unknown
Colusa Drain	5	Pesticides (Carbofuran) Unknown Toxicity	Agriculture Unknown
Feather River, Lower	5	Mercury Diazinon, Chlorpyrifos Group A Pesticides (Toxaphene) Unknown Toxicity	Mining Agriculture, Urban Agriculture Unknown
Harley Gulch	5	Mercury	Mining
Humbug Creek	5	Copper, Mercury, Zinc Sedimentation	Mining Mining
Little Cow Creek	5	Copper, Zinc, Cadmium	Mining
Natomas East Main Drain	5	PCBs Diazinon, Chlorpyrifos	Industrial, Urban Agriculture, Urban
Sacramento River (Shasta Dam to Red Bluff)	5	Cadmium, Copper, Zinc Unknown Toxicity Temperature	Mining Unknown Dam
Sacramento River (Red Bluff to Delta)	5	Mercury Diazinon, Chlorpyrifos Carbofuran Unknown Toxicity	Mining Agriculture Agriculture Unknown
Sacramento Slough	5	Mercury Diazinon, Chlorpyrifos	Unknown Agriculture, Urban
Sulfur Creek	5	Mercury	Mining

***Source:* *1996 California 303(d)* and TMDL Priority List**

303D.XLS
CALFED solution area
8/4/97

Clean Water Act Section 303(d) Listed Impaired Waterbodies
Within the CALFED Solution Area

Waterbody	Regional Board	Parameters of Concern	Probable Sources
San Joaquin River Basin			
Grasslands Marshes	5	Selenium TDS	Agriculture Agriculture
Merced River, Lower	5	Group A Pesticides (Toxaphene) DDT	Agriculture Agriculture
Mokelumne River, Lower	5	Copper, Zinc Dissolved Oxygen	Mining Dam
Mud Slough	5	Selenium TDS Boron Pesticides Unknown Toxicity	Agriculture Agriculture Agriculture Agriculture Agriculture
Orestimba Creek	5	Pesticides Unknown Toxicity	Agriculture Unknown
Panoche Creek	5	Mercury TDS Selenium	Mining Agriculture Agriculture
Salt Slough	5	Selenium TDS Mercury Pesticides Boron	Agriculture Agriculture Mining Agriculture Agriculture
San Carlos Creek	5	Mercury	Mining
San Joaquin River	5	Selenium Diazinon, Chlorpyrifos Unknown Toxicity Group A Pesticides (?) Salt, Boron	Agriculture Agriculture Unknown Agriculture Agriculture
Stanislaus River, Lower	5	Group A Pesticides (Endosulfan) DDT Unknown Toxicity	Agriculture Agriculture Unknown
Temple Creek	5	Ammonia	Dairies

Source:* *1996 California 303(d)
and TMDL Priority List

303D.XLS
CALFED solution area
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Clean Water Act Section 303(d) Listed Impaired Waterbodies Within the CALFED Solution Area

Waterbody	Regional Board	Parameters of Concern	Probable Sources
Tuolumne River, Lower	5	Group A Pesticides (Chlordane, Toxaphene) DDT Unknown Toxicity	Agriculture Agriculture Unknown
Turlock Irrigation District Lateral #5	5	Ammonia Pesticides Unknown Toxicity	Wastewater Discharge, Agriculture Agriculture Unknown

Note: These waterbodies represent CWA Section 303(d) impaired waterbodies within the CALFED solution area that are impaired due to the presence of one or more CALFED Water Quality parameters of concern.

Source: 1996 *California* 303(d) and TMDL Priority List

Clean Water Act Section 303(d) Listed Impaired Waterbodies Within the Bay Region that May Affect the CALFED Problem Area

Waterbody	Regional Board	Parameters of Concern	Probable Sources
Napa River	2	Pathogens Nutrients Turbidity	Urban Runoff, Agriculture Agriculture Agriculture, Urban Runoff
Petaluma River	2	Pathogens Nutrients Turbidity	Agriculture, Urban Runoff Agriculture, Urban Runoff Agriculture, Urban Runoff
Richardson Bay	2	Pathogens	Urban Runoff, Marinas
San Francisco Bay, Central	2	Metals	Municipal and Industrial Point Sources, Mining, Urban Runoff
San Francisco Bay, Lower	2	Metals	Municipal Point Sources, Urban Runoff
San Francisco Bay, South	2	Metals	Municipal Point Sources, Urban Runoff, Mining
San Pablo Bay	2	Metals	Municipal and Industrial Point Sources, Mining, Urban Runoff
Sonoma Creek	2	Nutrients, Pathogens, Turbidity	Agriculture, Urban Runoff, Construction

Note: These waterbodies represent CWA 303(d) impaired waterbodies within the Bay region that are impaired due to the presence of one or more CALFED Water Quality parameters of concern.

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Bay
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Clean Water Act Section 303(d) Listed Impaired Waterbodies
Above Dams Within the Sacramento River Basin that May Affect the CALFED Problem Area

Waterbody	Regional Board	Parameters of Concern	Probable Sources
Sacramento River Basin--Above Dams			
Berryessa Lake	5	Mercury	Mining
Clear Lake	5	Mercury Nutrients	Mining Unknown
Horse Creek	5	Copper, Cadmium, Zinc	Mining
Keswick Reservoir	5	Copper, Cadmium, Zinc	Mining
Little Backbone Creek	5	Copper, Cadmium, Zinc pH	Mining Mining
Shasta Lake	5	Copper, Cadmium, Zinc	Mining
Spring Creek	5	Copper, Cadmium, Zinc pH	Mining Mining
Town Creek	5	Copper, Cadmium, Zinc	Mining
West Squaw Creek	5	Copper, Cadmium, Zinc	Mining
Whiskeytown Reservoir	5	Pathogens	On-site Disposal Systems
Willow Creek	5	Copper, Zinc pH	Mining Mining

Note: These waterbodies represent CWA Section 303(d) impaired waterbodies above major dams within the Sacramento River Basin that are impaired due to the presence of one or more CALFED Water Quality parameters of concern.

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Above dams
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